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ABSTRACT

Included are the four information bulletins produced by the ERIC Clearinghouse for Science, Mathematics and Environmental Education for the calendar year 1980. The first issue contains an interpretative summary from the National Council of Teachers of Mathematics project "Priorities in School Mathematics" as well as announcements of recent ERIC/SMEAC publications in mathematics education. The second issue contains descriptions of materials on energy-related careers and announcements of recent ERIC/SMEAC publications in environmental education. The third issue is focused on information related to the topic of safety in the science classroom. Safety is discussed as it relates to teacher responsibility, general safety procedures in the science laboratory, and safety procedures for the use of chemicals, microorganisms, plants and animals, electricity, lasers, and model rockets. The fourth issue summarizes activities of the ERIC system in general and ERIC/SMEAC in particular and highlights nine ERIC/SMEAC documents in the form of expanded descriptive abstracts of each document. (Author/JN)

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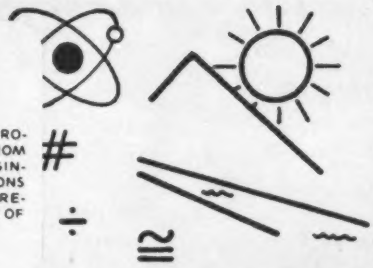

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An Interpretive Summary from the NCTM Project "Priorities in School Mathematics"

Editor's Comments

This issue of the ERIC/SMEAC Information Bulletin features a national survey conducted to determine preferences and priorities for school mathematics for the 1980's. The study was directed by Alan R. Osborne and others for the National Council of Teachers of Mathematics, Inc. and was funded by the National Science Foundation. The description of the study's findings was written by Gary Sweitzer, Graduate Research Associate and Information Analyst for Science Education, ERIC/SMEAC, and was based on reports prepared by Jon L. Higgins, Faculty Research Associate — Mathematics Education, ERIC/SMEAC. Dr. Higgins was one of the individuals involved in conducting the Priorities in School Mathematics (PRISM) project.

The final report on the project and appendices to the report are available from ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. The final report and appendices A and B are ED 184 891. Appendices C and D are ED 184 892. Persons wishing to obtain copies of this material should use an order form found in the back of an issue of *Resources in Education* (RIE) and should send it to EDRS. This material is *not* available from the ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Introduction

The PRISM study (Priorities in School Mathematics) was designed by the National Council of Teachers of Mathematics to help provide guidelines and suggestions for mathematics curriculum changes during the 1980's. The study contained two major components. The first of these (the preference study) presented a wide range of alternate content topics, instructional goals and methods, and teaching resources for the K-12 mathematics curriculum. Survey respondents were asked to identify their preference for the alternatives within the context of nine major areas (strands) of the mathematics curriculum. These strands were identified as follows: problem solving; computer literacy; whole numbers; fractions and decimals; algebra; measurement; ratio, proportion, and percent; geometry; probability and statistics.

The second component of the PRISM study assessed priorities for mathematics curriculum change and development. Respondents were asked to judge the relative importance of curriculum alternatives against each other. These data identify points in the mathematics curriculum where change is needed or most desired.

Although there are many theoretical bases for making curriculum decisions (both mathematical and psychological), the final implementation of curriculum change depends upon the individual preferences of teachers, administrators, and parents at the local school level. The PRISM study represents the first systematic attempt to assess these preferences and priorities *before* recommending curriculum development and change. Knowledge of current attitudes and preferences can be useful in predicting which curriculum changes may be readily adopted and which may meet with resistance. It does not, of course, provide information about the usefulness of the suggested alternatives, nor does it in any way limit the development of additional alternatives.

Many groups of people are involved in successful curriculum change, and the pattern of progress and failure depends upon agreements, disagreements, and interactions among these groups. The PRISM study identified nine such groups and contrasted preferences and priorities among them. Four groups of teachers were identified. Elementary and secondary teachers with particular interest in mathematics were sampled from subscribers to the NCTM publications the *Arithmetic Teacher* and *The Mathematics Teacher*. Junior college and college mathematics teachers were sampled from members of appropriate professional organizations. Teacher educators were also identified as an important group in implementing curriculum change, and were also sampled. Two groups of school administrators were identified: supervisors of mathematics and building principals. Finally, parents and other members of the general public were identified through samples of PTA presidents and of school board members. Many of the conclusions which follow highlight differences in the responses of these nine samples. Where there is general agreement among the samples, a conclusion is reported for the total reaction of all respondents. Because of the extreme length of the surveys, item-sampling techniques were used. Details of this sampling as well as the exact wording of survey items and complete patterns of response may be found in the full report.

Alternatives Within Strands

Problem Solving

Both professional and lay populations agreed on problem solving as a focus for the mathematics curriculum of the 1980's. More respondents indicated that curriculum emphasis on problem solving should be increased than for any other area. Over 95% identified the goal of problem solving as the development of methods of thinking and logical reasoning. Other goals that were strongly supported include the acquisition of skills necessary for living in today's world and techniques that are vital to having a well-rounded education.

Three problem-solving techniques that might be taught to students were strongly supported at both the elementary and secondary levels. These were: construct a table and search for patterns, translate the problem into number sentences or equations, and write and solve a simpler problem—then extend the solution to the original problem. Although there was moderate support for guessing and testing possible solutions, a suggestion that students generate many possible answers using a calculator or computer and then check to see which one meets the conditions of the problem was not supported. (Respondents did give moderate support for having computers and hand-held cal-

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culators available for problem-solving work, but it was not apparent from survey results just what they would do with them.)

Problem solving also received strong endorsement from PRISM respondents as the top priority for development of new materials at the elementary school level. Respondents noted that problem solving is a crucial skill for students and a major area of difficulty for teachers. Strongest support was given to the development of a resource guide to real-life problems, materials for modeling problems and problem solutions, and supplementary materials which contain many more problems like those in textbooks. Very strong support was also given to inservice training on problem-solving methods for all teachers who teach mathematics.

Computer Literacy

Substantial agreement and support across samples on the rank ordering of goals for computer literacy was apparent with over 80% identifying the development of logical thinking abilities and preparation for the future as important goals. The idea that knowledge of computers is only needed by specialists was strongly opposed (by 88.9%). Support for developing computer literacy topics for all students was second only to support for mathematical applications. More than 80% of those sampled believed that the computer literacy topics should include flow charting, writing programs in a simple computer language such as BASIC, operation of a programmable calculator, and learning about the roles of computers in society. Problem solving was also a strong focus for computer literacy, with more than 90% responding that children should be taught the types of mathematical and non-mathematical problems that can be solved by a computer. (Interestingly, including in mathematics courses issues of privacy and security raised by computers was given only moderate support.)

While there was substantial agreement on computer literacy goals, there was not strong consensus on the teaching strategies to accomplish those goals. Field trips for student observation of computer applications and individual student projects for the study of computer applications and their impact received the most support, but it was moderate.

When respondents were asked to assign priorities to the development of new instructional materials at the secondary level, they gave first priority to materials for computer literacy (over those for algebra, geometry, statistics, and probability). A course that helps students understand how calculators and computers handle mathematics was their second choice out of five possible courses that should be added to the high school curriculum.

Whole Numbers

Respondents recognized both practical and theoretical goals for learning whole number computation. Top-ranked by all but the college mathematics teacher sample was acquisition of skills necessary for consumer decisions. Ranked only slightly lower was the goal of developing fundamental understandings upon which other mathematics learning is built (this goal was top-ranked by the college mathematics teacher sample.) Other goals strongly supported were the development of logical thinking ability, understanding of the structure of mathematics, and the acquisition of qualifications for obtaining jobs.

Seventy-two percent of the respondents to the whole numbers portion of the questionnaire agreed that a calculator should be available for every student. But 91% felt that every student should master whole number computations with paper and pencil before graduating from high school. Similar percentages agreed that techniques of estimation and mental calculation (without the aid of paper and pencil) should be taught. Other whole number content supported included specific strategies for solving word problems, mathematical puzzles and games, developing operations simultaneously, and the teaching of specific consumer skills such as balancing a checkbook or computing best buys. Specific uses of a calculator were limited to checking answers, adding the costs of several items in a grocery cart, or doing a chain of calculations involving several different operations and the paper-and-pencil algorithms for them. Using a calculator to learn basic facts was opposed by 57%; use for calculating change from a five dollar bill was opposed by 65% and using a calculator on a whole number computation test was opposed by 78%. Thus while acknowledging that children should have calculators, respondents would make limited use of them and would continue to stress both paper-and-pencil and mental arithmetic.

There was general agreement across samples on the inclusion of four resources for teaching about whole numbers. These materials were identified as resource books compiling examples of arithmetic applied to real-life situations, masters of worksheets and activities, standardized practice tests, and packaged materials for individual study.

Fractions and Decimals

Fractions will continue to play an important role in the mathematics curriculum of the 1980's. Almost 96% of the professional samples opposed omitting fractions entirely from the curriculum. A similar percentage disagreed with the suggestion that only college-bound students be taught fractions. A suggestion that all students should master operations with decimals, but not all should be expected to master operations with fractions, was opposed by 60%.

The most strongly supported goal for both fractions and decimals was that they were used in many vocations such as auto mechanics, carpentry, plumbing, etc. Vocational practicality seemed to be particularly dominant theme for decimals. The second- and third-ranked goals for decimals were that consumers need decimals for computing "best buys" and that decimals are used in money. On the other hand, respondents clearly opposed introducing decimals by relating them *exclusively* to money. Instead, the indication was that decimals should be developed as a means of naming numbers between numbers.

There is some evidence that respondents attach more importance to decimals than to fractions. Approximately 66% would give increased emphasis to decimals during the 1980's, but only 44.1% would give increased emphasis to fractions. When asked to rank five elementary content areas as to the priority for developing new curriculum materials, decimals was ranked second (behind problem solving), while fractions was ranked last. Minimal support (55.5%) was given to the idea that more attention should be given to operations with decimals than operations with fractions. But responses were fairly evenly divided to the suggestion that operations with decimals be included in the first- or second-grade mathematics program (the most opposition came from the mathematics supervisor, teacher, educator, and lay samples.)

Moderately strong support was given to presenting fractions as answers to division problems (e.g., 6/12 means 6 divided by 12). In contrast, only minimal support was given to developing fractions as measures of length. (These suggestions were made separately for elementary level and for secondary level—responses were essentially the same at both levels.) The resources most desired for teaching fractions and decimals were drill and practice materials, masters of worksheets and activities, resource booklets with applications, and individual study materials. In contrast, the desire for student sets of measuring devices and for manipulative materials ranged from ten to twenty percentage points less. Apparently survey respondents are satisfied with a relatively abstract approach to fractions. Despite the abstractness of this approach, more than 75% opposed the suggestion that work with fractions should be delayed until seventh or eighth grade. One concession was made: 75% agreed that students should be taught fractions with small denominators useful in various vocations. Support of this item was particularly strong from the mathematics supervisor and teacher educator samples; support was minimal from the college mathematics teacher sample.

Thus while survey respondents stress the practical uses of fractions and deci-

mals as goals (reasons) for their inclusion in the curriculum, they seem to support a relatively abstract approach to content and teaching resources for these areas. Although there is some acknowledgement that decimals should receive increasing attention, it is not clear from survey results what should be the focus of this attention.

Algebra

Survey respondents seemed to recognize two types of goals for algebra. Very strong support was given to the practical goals of learning how to apply mathematics and gaining skills necessary for work and vocations. However, support was almost as strong for the goals of preparing for college and for building the background for taking more mathematics. Indeed, 70% of the respondents felt that different algebra courses should be offered for students with different interests and abilities, and that a special algebra course should be offered for vocational students.

Should every student graduating from high school be required to take a full-year algebra course? More than 80% of the respondents from the college mathematics teacher sample agreed that this would be a good policy. But almost 65% of the lay samples (drawn from principals, school board members, and PTA presidents)disagreed, as did nearly 75% of the mathematics supervisor sample. When asked about specific algebra topics that should be studied by all students, strong support was given to signed numbers, linear equations, evaluating formulas, exponents, and writing equations to solve word problems. But respondents generally opposed requiring all students to study systems of equations, writing computer programs, sequences and series, finite systems, quantifiers and set notation, or proving algebraic generalization. Thus the list of topics to be taught to all students would not go beyond those which have been in seventh- and eighth-grade textbooks for years, and would include very little of what was incorporated into textbooks at that level under the name of modern mathematics during the 1960's.

The *Arithmetic Teacher*, mathematics supervisor, and teacher educator samples were asked about including algebraic topics in elementary schools. Of fifteen topics suggested, four were very strongly supported: solving open number sentences, making generalizations about numerical patterns, writing equations to solve word problems, and inequalities.

The Mathematics Teacher sample, junior college and college mathematics teacher samples, mathematics supervisor and teacher educator samples identified from a list of twenty advanced algebraic topics those they would include for the general college-bound population. Limits and continuity and topics from introductory calculus were generally opposed, as were vectors, vector spaces, and algebraic structures (groups, rings, and fields). However, strong support was given to the inclusion of probability functions (e.g., probability theory) and mathematical models.

Thus it appears that all survey respondents were conservative when considering algebra topics for all students in either elementary or secondary schools, but were willing to expand algebra topics in advanced courses for college-bound students. Opinion seemed to reserve introductory calculus topics for college-level courses, however.

Measurement

Six goals for teaching measurement were strongly supported by over 80% of the respondents. These goals involved acquiring skills for living in today's world, for other school work, for use in the home, for estimation, for jobs, and for using specific tools. Development of estimation skills and experience in dealing with estimation and approximation were strongly supported (above 82%) as goals that were appropriate for probability and statistics as well as for measurement. An average of 92% of the respondents also supported the teaching of estimation in connection with whole number work.

Both the lay samples and the professional samples recognized the importance of measurement in the elementary school. There was strong support (96%) for teaching the metric system at both elementary and secondary levels. Nearly 73% of the survey respondents favored increased emphasis on the metric system during the 1980's. Teaching of conversions between different measuring systems at the elementary level was opposed by 63% of the respondents. Teaching of conversion was also opposed at the secondary level by the mathematics supervisor and teacher educator samples, but strongly supported by the college mathematics teacher sample and given moderately strong support by the junior college teacher sample.

Respondents also gave strong support for teaching estimation and approximations of measures at both the elementary and secondary levels. However, support for teaching significant digits was only moderate (61%) at the secondary level, and weak (49%) at the elementary level. Respondents also felt that the use of measurement devices (e.g. ruler, protractors, micrometers) should be taught at the elementary level. At the secondary level, 85% would teach the multiplication and division of units (e.g. miles/hr X hr - miles).

The resources most desired for teaching measurement were resource books with problems involving the application of measurement concepts, masters of worksheets and activities, student booklets of experiments or activities, and a basic kit of measuring tools for each student.

Ratio, proportion, and percent

All survey samples seemed to have a very practical inclination when responding to items on ratio, proportion, and percent. Of the ten goal statements suggested, the three involving the most practical applications received the strongest support: to acquire consumer skills, to develop proportional thinking as a problem-solving technique, and to acquire skills for vocational applications. Respondents gave very strong support to the introduction of percent through merchandising or other real-life contexts. Sixty-nine percent agreed that ratio should be introduced as a method for determining the "best buy" in a supermarket or sporting goods store. Respondents tended to agree on items involving the teaching of percent, but seemed to be less certain about the approach that should be taken when teaching ratio and proportion.

There was moderate support (63.6%) for considering the mastery of percent problems as a condition for high school graduation, and less support (56.4%) for devoting more curriculum time to ratio and proportion.

The practical inclination of the respondents continued in their selection of desired resources. Over 93% of the respondents selected resource books of applications of ratio and percent to real-life problems.

Geometry

What are the reasons for teaching geometry? Survey respondents chose reasons from a list containing both classical statements (e.g., to develop logical thinking abilities) and practical statements (e.g., to develop job-oriented skills). They strongly preferred the classical statements, including the general goal "to acquire knowledge for further study."

All samples supported the introduction of geometry before seventh grade. In fact, 65% felt that intuitive geometric concepts were at least as important in grade one as number concepts. The adjective "intuitive" is very important in this statement, however, since there was strong opposition to the use of axioms, proofs, or "logical reasoning principles" anywhere in elementary school geometry.

Survey respondents apparently believed that work in geometry should be required of all pupils after seventh grade, since they indicated that the present geometry taught to elementary schools was *not* an adequate minimum knowledge for high school graduation. But respondents had no clear preference for how this should be accomplished. The junior college and college mathematics teacher samples, as well as the teacher educator sample, tended to support increasing the portion of the seventh and eight-grade curriculum devoted to geometry. But the *Arithmetic Teacher* and *The Mathemat-*

ics Teacher samples and the lay samples tended to oppose this idea. Apparently these groups still preferred a traditional separate geometry course somewhere after grade seven. Indeed, all samples were opposed to the idea of abolishing separate geometry courses and integrating geometry content with other mathematics in grades K-12.

At which level should the separate geometry course be placed in the secondary curriculum? All samples opposed the suggestion that it be delayed until after students had two years of algebra. (The college mathematics teacher sample was particularly opposed to this suggestion.) One should thus note a traditional pattern of preferences emerging with respect to geometry: introduction of intuitive geometry in elementary schools, culminating in a separate geometry course probably placed between Algebra I and Algebra II.

This pattern of traditional preferences was confirmed when one examines preferences about specific geometric content. Topics most strongly preferred for elementary school geometry were properties of triangles and rectangles, parallel and perpendicular lines, symmetry, and similar figures. Responses were much the same for topics that should be studied by all students at the secondary level. Preferred were properties of triangles, rectangles and circles, similar figures, and coordinate geometry.

Respondents were asked about including in elementary schools such non-traditional topics as vector geometry, projective geometry, spherical geometry, and tesselations. Responses were equivocal in all cases, with no clear patterns of support or opposition emerging. But there was clear opposition at the secondary level (for all students) to the inclusion of finite or non-Euclidean geometries, and moderate opposition to the inclusion of tesselations and symbolic logic.

Survey respondents were also asked about geometry topics for the college-bound student who would not be a science or mathematics major. Apparently they would require only a very few advanced topics, since only coordinate geometry and straightedge-and-compass construction were strongly preferred. On the other hand, the availability as an elective of a full-year course in applied geometry was supported by all samples. Since few specific topics were supported, this may indicate the appeal of applications for all areas of the mathematics curriculum.

Respondents at all levels expressed a preference for a resouce-rich environment for teaching geometry. While the highest support was for resource books, short films and videotapes, and worksheet and activity masters, other items with over 69% support included individual study materials, demonstration models, manipulative materials and laboratory experiments, measuring tool kits, 35mm slides, and computer generated animated graphics.

Probability and Statistics

Almost 84% of the respondents agreed that the importance of probability and statistics was in applying mathematics to other disciplines. Nearly 95% agreed that the goal of probability and statistics is to enable students to read and think critically about graphs and data in other subjects such as science or social science. Indeed, the resource for teaching probability and statistics which received the strongest support was resource books with applications and problems (90.8%). Materials that include many examples of real-world data were supported by 94.3% and the use of problems that arise in the social or natural sciences to extract and develop concepts was also supported. Over 86% of the respondents supported the idea that students should perform experiments with dice and cards and study games of chance. On the other hand, there was only moderate support (53.1%) for providing students with ready-made data bases from previously completed experiments. The junior college mathematics teacher sample was particularly strong in their support of experiments and laboratory equipment for probability and statistics.

Development of new curriculum materials for probability and statistics during the 1980's was not given high priority by PRISM respondents. When asked to assign priorities to the development of new materials for secondary schools in five curriculum areas (including computer literacy, algebra, and geometry), statistics was ranked fourth, and probability was ranked last. Strongest support for statistics and probability came from the mathematics supervisor sample. Statistics (but not probability) was also supported by the teacher educator sample. Opinion seems to support an elective high school course in probability and statistics (76.9% support), but not a required course. Almost two-thirds of those sampled opposed requiring a probability and statistics course for all ninth graders.

The integration of probability and statistics topics into regular mathematics courses was another matter, however. Nearly 70% of the respondents agreed that ideas from probability and statistics should be included in every mathematics textbook from grades one through eight. When asked specifically about topics for elementary students, strongest support (above 85%) was given to the collection and organization of data and to reading and interpreting statistical information. Decision-making and measures of central tendency were moderately supported. (These four topics were also endorsed as suitable for *all* secondary students.) Probability topics such as predicting outcomes and calculating the probability of an event occurring were also given moderate support for elementary students (76.1% and 63.6%, respectively.). At the secondary level probability distributions, combinations and permutations, calculating probabilities of compound and conditional events, and curve fitting and prediction were supported as appropriate for college-bound students, but not for all secondary students. This may explain why the development of materials for statistics was given a slightly higher priority than the development of materials for probability.

Alternatives Across Strands

Respondents were asked to list the order in which five areas should be studied or developed during the 1980's: improved mathematics content for textbooks, development of materials for students with special needs, improved preservice and inservice education, development of non-text materials, and improvement of teaching methods and techniques. The area given highest priority by all professional samples was preservice and inservice education. The sample drawn from school principals ranked preservice and inservice education second, only behind the improvement of teaching methods and techniques. However, the school board and PTA president sample ranked teacher education fourth of the five areas (ahead of only non-text materials). Their first choice, like the principal sample, was the improvement of teaching methods.

Teacher Education

PRISM survey respondents believed strongly in teacher education. When asked to compare fifteen methods for attacking problems in mathematics education on the basis of general importance, practicality, and efficiency, inservice education was rated first and preservice education was rated second. The samples drawn from school board members and PTA presidents (SB/PT) tended to see inservice education as more important than preservice education, but this happened because they rank methods over which they are apt to have local control (e.g., grants to local schools) higher than methods that are more removed from their immediate influence.

Improving teaching methods is very compatible with preservice and inservice education, and can even be considered a goal of preservice and inservice education. Other possible teacher education goals included further knowledge of mathematics content, development of teaching materials, development of sensitivity to student needs, and knowledge of diagnostic and remediation strategies. When asked to rank these five areas (goals), methods for teaching mathematics was clearly the first choice for all samples except the SB/PT sample. This sample ranked methods second to sensitivity to student needs. There was a favorable reaction to sensitivity to stu-

dent needs. There was a favorable reaction to sensitivity to student needs by the *Arithmetic Teacher*, supervisor, and principal samples as well; only *The Mathematics Teacher* and teacher educator samples reacted negatively to it. The opposite pattern was in evidence on the reactions to knowledge of mathematics content, however. *The Mathematics Teacher* and teacher educator samples reacted positively to content; all other samples tended to react negatively. The supervisor sample reacted more positively to the area of diagnosis and remediation than did any other sample.

There was broad and general support for both preservice and inservice teacher education, and there was a definite preference for teacher education work to be focused upon teaching methods. Other areas of teacher education had different champions among different survey samples.

Curricular Approaches

Mathematics has traditionally been viewed as a discipline which "teaches people how to think." This view is not likely to change during the 1980's. Developing logical thinking ability as a general goal for mathematics received very strong support (over 93%) from all lay samples. Developing logical thinking ability as a goal for whole numbers, geometry, and probability and statistics received very strong support (over 90%) from most professional samples; as a goal for computer literacy, support for logical thinking was only slightly less (80%).

Apparently the desire of most respondents was to treat logical thinking indirectly rather than specifically. Symbolic logic as a topic for all students received very little support (31%). It did receive minimal support for college-bound students who will not be mathematics or science majors. There was very little support for increasing the emphasis on proof or formal axiomatic structures, either. For the latter, a higher percentage favored decreasing emphasis (31.7%) rather than increasing emphasis (14.4%). On the other hand, the goal of learning to read and interpret mathematical arguments *was* strongly supported. Emphasizing reasoning techniques for ratio, fractions, decimals, and secondary geometry received moderately strong support (61% to 82%); however, emphasizing logical reasoning principles in elementary school geometry was not supported (44.6% opposed).

The modern mathematics movement emphasized the inherent structures of mathematics, but increasing the emphasis during the 1980's on curricula based on the logic of mathematics in order to understand the structure of mathematics was strongly supported for whole numbers (82.4%) and moderately supported as a generic (general) item (74.9%).

The study of structural properties of number systems received higher support at the elementary level (68.5%) than at the secondary level (52.8%). When the study of properties of classes of numbers (e.g., integers, rationals, reals) was specified, support dropped even lower (49%). The tendency of respondents to rate general statements higher than specific examples was a pattern that is noticable throughout the PRISM survey.

Teaching Methods

Increasing the emphasis on individualization during the 1980's was given moderately strong support by the *Arithmetic Teacher*, supervisor, and teacher educator samples and by all the lay samples (principals, school board members, and PTA presidents). However, support for individualization was decidedly weaker among *The Mathematics Teacher*, junior college teacher, and college mathematics teacher samples. All groups gave moderately strong to strong support for providing classroom teachers with individual study materials for classroom use in the areas of fractions, whole numbers, geometry, probability and statistics, ratio and proportion, and measurement.

Many respondents saw individualization as only one of several teaching techniques that should be used in the classroom. They were rather evenly divided as to whether more than 50% of the instructional time should be devoted to student use of individual study materials to develop and extend ideas. Instructional materials with specific objectives, criterion-referenced testing, and other aspects of a mastery learning or individually-paced model were given moderately strong support (above 63%) by all except the college mathematics teacher sample (which gave very little support). As might be expected, specifying competency levels in instructional materials received very strong support by lay samples (above 92%).

Respondents were asked about dividing classes into small groups for group work. Having students work in small groups to solve problems was given a higher degree of support (70% to 80%) than dividing the class into small discussion groups (38% to 58%). Most samples gave moderately strong support for having students develop ideas through long-term or real life projects for the areas of ratio, proportion, and percent; geometry; and probability and statistics. But project work for fractions and decimals and for algebra was not supported.

Films, videotapes, and large-scale demonstration devices received strong to moderately strong support from all samples (ranging from 71% to 88%). The use of audiotapes for drill and practice was supported at the 75% level; however, audiotapes of lectures were negatively perceived by all samples. Providing students with measuring devices as resources for fractions and decimals, geometry, and measurement was given moderately strong support (73% to 80.5%), but when electronic measuring devices with calculator-like readout were suggested, support dropped to 45%.

When asked how much emphasis should be given to mathematics laboratories in the 1980's, only 48.2% indicated that they should be given increased emphasis, while 34.2% opted for the same level of emphasis, and 16.3% would give them "somewhat less emphasis." Lay samples gave stronger support (above 93%) to the use of physical materials and models than did professional samples; however, the use of materials for modeling problem-solving situations was supported by 83% of the professional samples. There was strong support for the use of manipulative materials in whole number mathematics from all samples except the college mathematics teacher sample (which gave only minimal support). There also was strong support (above 87%) for introducing basic ideas through laboratory investigations or experiments with materials at *both* the elementary and secondary school levels.

Survey participants were asked to imagine that an additional fifteen minutes per day could be spent on mathematics in elementary schools: how would they use this time? Respondents gave the highest priority to solving word problems, and the next highest priority to studying applications of mathematics. Nearly 80% indicated that students should be taught to *find* problems within situations; however, support was minimal (58.7%) for offering an interdisciplinary problem solving course.

Almost 66% of the respondents agreed that more than 50% of the instructional time for basic facts should be devoted to drill and practice. Lay samples gave moderately strong support (71.4%) to drill and practice in general, but the mathematics supervisor and teacher educator samples tended to disagree with the allotment of so much time to drill and practice. There was generally stronger support (above 80%) for providing practice worksheets at the conclusion of every mathematics lesson, no matter what content was involved. The *Arithmetic Teacher*, *The Mathematics Teacher*, junior college, and college mathematics teacher samples gave strong support (81.9%) to providing whole number drill and practice in standardized test formats so that students would be prepared for later testing. However, mathematics supervisor and teacher educator samples gave only minimal support to standardized test formats for practice worksheets.

Well over 80% of the lay sample and approximately 70% of the professional samples indicated that basic skills should be given increased emphasis in the 1980's. When asked how they would spend an additional 15 minutes per day in elementary school mathematics, *The Mathematics Teacher* sample and the lay samples gave first priority to drill on

basic number skills. Other samples ranked problem solving and applications above basic skills as a focus for extra-time work. While basic skills received strong support for additional emphasis in the 1980's, the areas of problem solving, mathematical applications, and mathematics for gifted students received even stronger support.

Resources

Participants were asked about new or additional teaching resources that might be useful in several content areas. In every area where they were suggested—whole numbers; fractions and decimals; ratio, proportion, and percent; measurement; probability and statistics; algebra; geometry, and problem solving—resource booklets containing applications were strongly supported by over 80% of the respondents. In fact, resource booklets of applications were the most desired teaching resource in every area except fractions and decimals. On the other hand, collections of problems and applications meant to appeal to special groups, such as women or ethnic minorities, were only weakly supported. There was consistently strong support (above 80%) for using applications as a context for developing mathematical ideas and other instruction. Using applications as teaching methodology received even stronger support from the lay samples than from the professional samples. The key to this support seemed to be realism. Approximately 72% of the lay samples agreed that problems should be realistic even though they might involve sensitive social issues.

Instructional materials that included activities which required students to go outside the classroom were given moderately strong support by the supervisor, teacher educator, and lay samples. Probability and statistics, measurement, and computer literacy were perceived as more suitable for out-of-class activities than were whole numbers; geometry; ratio, proportion, and percent; or problem solving.

The availability of special materials with minimal reading requirements was given moderately strong support by the *Arithmetic Teacher*, supervisor, teacher educator, and principal samples. However, *The Mathematics Teacher* sample gave weaker support, and the junior college and college mathematics teacher samples tended to oppose the idea. The school board member and PTA president samples also opposed the idea that reading should be deemphasized in textbooks and other materials. And "learning to read mathematics" received moderately strong support as a basic goal for whole numbers, algebra, and problem-solving (70.4% to 77.7%). Apparently reading was viewed as an important component of problem-solving; 54.1% disagreed with the oral presentation of problems or with the use of pictures and charts as a means to deemphasize reading.

Providing teachers with a syllabus that suggests topics and methods for each grade level with specific times these should be introduced received moderately strong support (70.9%) at the elementary level from the supervisor and teacher educator samples. However, support for the same idea at the secondary level was minimal (56.6%). The need for detailed notes to guide the teacher in oral presentations of lessons was seen as greater for computer literacy and for probability and statistics (over 62%) than in other content areas, where the level of support was 50% to 60%.

Classroom Technology

Nearly 75% of the professionals sampled and 80% of the lay people sampled believed that the use of computers and other technology in mathematics classrooms should be increased during the 1980's. Respondents also gave very strong support to having computers or computer access for students at the secondary school level; support was slightly stronger for having several minicomputers than for having terminals connected to large computer. Although there was moderately strong support for having computers available at the elementary school level, almost no one believed that programming should be introduced in the elementary school. However, there was minimal support (57.7%) for having students interact with a computer or computer terminal as early as the primary grades. For the 1980's, at least, computers seem to be clearly placed within the domain of mathematics departments. Eighty-one percent of the respondents opposed teaching computer literacy courses primarily within the social studies curriculum, and fifty-two percent opposed the establishment of separate computer science departments in high schools.

The uses and importance of calculators in the mathematics curriculum depended primarily upon the audience surveyed. Strongest support for calculators came from the mathematics supervisor and teacher educator samples. From 73.7% to 85.3% of them believed that calculator usage in the classroom should be increased. They strongly supported (above 80%) the use of calculators to develop ideas and concepts, check answers, solve word problems, do homework, solve equations, do a chain of mixed calculations, compute area, and make graphs. The supervisor sample strongly supported the use of calculators to learn why an algorithm works, although the teacher educator sample gave only moderate support to this idea. Even the use of calculators when taking a test was supported by these groups (74.8% and 83.1%).

The *Arithmetic Teacher* and *The Mathematics Teacher* samples and the junior college and college mathematics teacher samples had more reservations about using calculators. They gave very little support (44.7% to 51.3%) to increased emphasis on the use of calculators (although 20% or less in each sample would decrease calculator use). They gave moderately strong support (66.5%) for using calculators to develop ideas about decimals, but not about fractions or algebra. However, using calculators to *explore* values of algebraic expressions or limits of sequences was supported at the 70% level or above. Moderately strong support was given to the use of calculators to solve word problems in the areas of whole numbers and ratio, proportion, and percent, but very little support was given to using to solve word problems in algebra. Minimal support (54%) was given to using calculators to solve algebraic equations; for geometric formulas, the approval rose to 68% to 83.4%. The reaction to using calculators when doing homework also depends upon the content involved. There was much stronger support for using calculators to do homework in probability and statistics (84.5%) and in ratio, proportion, and percent (70.9%) than for for homework with fractions (36.5%) or geometry (54.7%). Interestingly, using calculators to do homework with decimals, whole numbers, and measurement all received moderate support (60% to 66%). Moderately strong support was also given to using calculators to do a chain of mixed calculation and to compute areas. As might be expected, the level of support rose as the complexity of these problems rose. Strongest support of all came from using calculators to check answers. The pattern of support for using graphs was mixed. The *Arithmetic Teacher* and *The Mathematics Teacher* samples gave less support to graphing (48.7% to 62.2%) than did junior college and college mathematics teacher samples (70% to 76%). Finally, using a calculator when taking a test was generally opposed for whole numbers, fractions, and decimals; opinion was divided in the case of algebra; and use was favored for measurement; ratio, proportion, and percent; geometry; and probability and statistics.

The lay samples, especially the PTA president sample (PT), tended to react at the other end of the spectrum. Forty-two percent of the PT sample felt that the use of calculators in the mathematics curriculum should be *decreased*. Strong support was given to checking answers with calculators, but over 70% of the PT sample opposed the use of calculators when doing homework or taking tests. Forty-six percent of the PT sample opposed the use of calculators for solving word problems, and opinion was divided on their use for developing ideas and concepts.

There was general agreement by all samples that basic facts should be learned first, before calculators are used. There was a strong belief that calculator use should be postponed until after paper-and-pencil algorithms are

learned. Wide-spread support existed for the use of calculators in trigonometry. Beyond these areas, however, little consensus existed. Successful integration of calculator uses throughout the mathematics curriculum will require careful and thorough communication among all constituent groups.

Courses and Programs

Survey participants were asked to choose one new or extensively revised course to be added to the high school curriculum from a set of five choices. "A course that helps students make decisions about buying and selling" was the first choice of respondents. Third choice (after computers and calculators) was "a course that helps students understand the mathematics used in specific vocations and careers." When asked about the relative emphasis that should be given to different orientations of mathematics (without specifying an entire course), career or vocational orientation was top-ranked, with consumer orientation given second-choice. (Other choices were computer orientation, college-preparatory orientation, and recreational orientation.)

Increased emphasis for gifted students was supported by over 75% of most samples. This response was exceeded only by the responses for increased emphasis given to problem solving and applications of mathematics. If more mathematics were offered to talented or gifted students, all samples would choose "a broad selection of topics" (60.0%), and would next choose work on computers and numerical analysis (22.9%).

What is the priority for addressing the needs of other types of students? All respondents agreed that students with mathematics learning problems and other handicaps should have first priority, and that inner-city or urban-area students should have second priority. Students of ethnic minority background, students whose first language is not English, and female students ranked third, fourth, and fifth, respectively. Although increased emphasis for women was supported by 52.5% of most samples, 40% indicated that women in mathematics should receive about the same emphasis as now. Different problem-solving courses for girls were strongly rejected, and very little support was shown for providing resource books with problems that appeal to girls.

Lay samples felt that mathematics programs were "about the same" in evaluation as other academic programs in their schools. Professional samples were almost evenly divided between evaluating the mathematics program as "better" or "about the same" as other academic programs in their schools. More need was seen for improving mathematics for general education than for improving mathematics for vocational students or college-bound students.

Approximately 60% of all respondents indicated that the general problems that face teachers deserve priority over those problems specific to the teaching and learning of mathematics. There was a fair agreement across samples on how such problems are ranked. Unmotivated students, reading difficulties, and classroom discipline were of greatest concern. The problem of least concern to all samples was that of restrictions on instructional materials. In general, problems involving characteristics or behaviors of students were of more concern than problems involving characteristics of schools, programs, or materials. Lowering of academic standards and lack of commitment to homework were of greater concern to *The Mathematics Teacher* sample than to other samples. The combined school board and PTA president samples tended to be more concerned about governmental restrictions and less concerned about teacher workloads than were other samples.

The highest priority as a method for attacking problems in mathematics was given to the inservice and preservice education of teachers. Evaluation of mathematics learning and achievement, allocation of grant money to local schools to improve their mathematics programs, and support of long-term research projects were ranked third, fourth, and fifth, respectively. First priority on distribution of research funds was given to studies of how students learn, with second priority given to research on teaching methods and third priority to research on teacher education.

In general, funding for local, small-scale projects was generally given priority over large-scale national projects. Least support was given to national curriculum projects and grants to commercial firms.

While PRISM respondents showed a very practical orientation to mathematics, it should be noted that this was not their exclusive pattern of response. They also strongly supported such goals as "to learn to read mathematics, to develop . . . understandings upon which other mathematics is built, to develop logical thinking abilities, and to understand the structure of mathematics." But overall, they saw a great need for developing practical applications of mathematics during the decade of the 1980's.

ERIC CLEARINGHOUSE FOR SCIENCE, MATHEMATICS, AND ENVIRONMENTAL EDUCATION
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Patricia E. Blosser
Bulletin Editor

Recent ERIC/SMEAC Publications

Readers wishing to order a copy of any of these publications may either purchase them from the ERIC Clearinghouse for Science, Mathematics and Environmental Education or may order from the ERIC Document Reproduction Service (EDRS), P.O. Box 190 Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or papercopy. Prices and ordering information are found in the document resumes in *Resources in Education* (RIE) as are order forms. Any Clearinghouse documents with SE numbers have been sent to EDRS for publication in a future issue of *Resources in Education* and will have an ED number when each appears in print.

Mathematics Education

Calculators: A Categorized Compilation of References
Marilyn N. Suydam ED 171 572

Annotated references dealing with the use of calculators in education are presented, with each entry including a limited set of descriptors to denote the focus of the reference. An index is included.

Task Variables in Mathematical Problem Solving
Gerald A. Goldin and
C. Edwin McClintock, editors
ED 178 366

Variables describing problem tasks are categorized and defined to provide a framework for research in problem solving. A model for the classification of task variables into broad categories is presented. Other articles relate to the definition and discussion of each category of task variables, with examples. The existing research literature is surveyed and theoretical implications of task variables within a category are explored.

Applied Mathematical Problem Solving
Richard Lesh, Diane Mierkiewicz, and
Mary Kantowski, editors ED 180 816

Nine papers are presented, relating to varied perspectives on applied problem solving.

Understanding the Realities of Problem Solving in Elementary School With Practical Pointers for Teachers
Linda Brandau and Jack Easley
ED 179 424

Part I of this document is focused on an attempt to connect the reality of the classroom with the idealism arising from some of the problem solving literature. Part II contains an examination of what "problem solving" might mean in the context of an elementary school classroom. A consideration of how children may be helped to understand the nonarbitrary character of rules of arithmetic by examining the connectedness of mathematical ideas, rules and procedures is found in Part III. A list of references and recommended readings, a list of specific pointers for teachers, and a conclusions section are also included.

An Analysis of Mathematics Education in the Union of Soviet Socialist Republics
R. B. Davis, T. A. Romberg,
S. Rachlin, and M. G. Kantowski
ED 182 141

The current status of mathematics education in the Union of Soviet Socialist Republics is reported. Discussed are common practices in present Soviet schools, difficulties in language, Soviet mathematics curricula, and mathematics education research and development in the Soviet Union. Soviet approaches to the study of problem solving processes in mathematics are considered.

Assessing Mathematical Achievement
Jon L. Higgins, Margaret Kasten, and
Marilyn N. Suydam, compilers
ED 182 146

Designed to serve as a reference on assessments of achievement in precollege mathematics, this report contains a discussion of mathematical assessments in terms of the history and nature of assessments of achievement, the relationship between assessment and minimum competency testing, and the current status of state assessment programs. Portions of reports of the National Assessment of Educational Progress and the California Assessment, grades 6 and 12, are presented in order to examine trends in mathematics achievement.

Some Theoretical Issues in Mathematics Education: Papers from a Research Presession
Richard Lesh and
Walter Secada, editors ED 180 815

Three addresses by internationally renowned mathematics researchers and a fourth paper on the role of research are presented. Each of the addresses (by Heinrich Bauersfeld, Efraim Fischbein, Hans Freudenthal) focuses on the learning process but from different points of view.

Research Reporting Sections, Annual Meeting of the National Council of Teachers of Mathematics (58th, Seattle, WA, April 16-19, 1980)
Jon L. Higgins, editor ED 182 144

Abstracts of 14 research reports relate to such topics as the effects of games on mathematics skills and concepts, sex differences in mathematics achievement and participation, locus of control and mathematics instruction, and the psychology of problem solving.

A Categorized Listing on Research on Mathematics Education, 1974-1978
Marilyn N. Suydam SE 030 730

Articles, dissertations, and ERIC documents for the five-year period are included. An index contains research reports grouped by categories for major topics.

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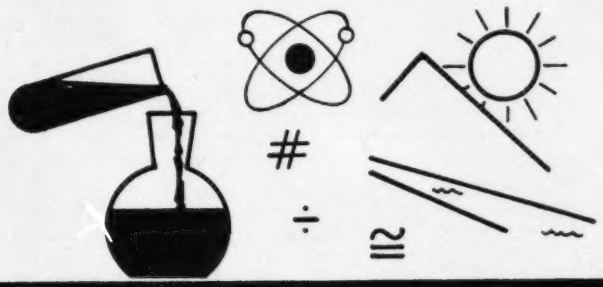

Materials on Energy-Related Careers

Editor's Comments

This issue of the ERIC/SMEAC information bulletin contains descriptions of materials on energy-related careers. Materials described were announced in either *Resources in Education* (RIE) or *Current Index to Journals in Education* (CIJE).

Persons interested in obtaining copies of any of these materials should check a recent issue of RIE for an order form and for any changes in the price of paper-copy or microfiche copies of the documents. Most of the articles announced in CIJE are available from University Microfilms International. Ordering information for copies of such articles is given at the beginning of the section of the bulletin in which the articles are described.

This issue of the bulletin was prepared by Bernard J. Lukco, Education Specialist, National Training and Operational Technology Center, Cincinnati, Ohio.

SECONDARY

The College of Education, Texas A and M University, has produced a 37-page publication that serves as an introduction for high school students to energy-related careers. Information on careers in manufacturing, business and industry, and electrical energy production is featured. The purpose of the document is to guide interested students into productive careers that will help solve serious national problems related to energy. Twenty-one careers are described. An overview of each occupation, future opportunities, general requirements, and estimated salaries are included for student use.

Copies of *Energy Related Careers* (ED 167 414) can be obtained for $3.32 for paper copy, $0.38 for microfiche, from:

ERIC Document Reproduction Service
P.O. Box 190
Arlington, VA 22210

POST SECONDARY

A data report describing the procedures and findings of a summer 1978 peer-to-peer telephone information exchange between the Education Programs Division of the U.S. Department of Energy, and various vocational-technical schools throughout the United States represents a preliminary investigation of a comprehensive study to assess the state of the art of energy education activities within two-year post-secondary educational institutions. The energy areas investigated were coal technology, petroleum technology, nuclear technology, solar energy, energy conservation, and energy generation and transmission.

The peer-to-peer telephone information exchange was designed to meet five major objectives:

1. To determine number and types of energy-related occupational-technical programs currently being offered by a representative sample of post-secondary vocational-technical institutions.
2. To determine number and type of energy-related occupational-technical programs being planned by a representative sample of post-secondary vocational-technical institutions.
3. To assess public interest in energy-related occupational-technical areas by ascertaining which energy-related short courses have been offered in the past two years in a sample of post-secondary vocational-technical institutions.
4. To determine the expressed need and current funding for energy-related occupational-technical programs within the public and private sectors of a representative sample of postsecondary vocational-technical institutions.
5. To assess the need for information dissemination about energy-related occupational-technical programs among vocational-technical institution staffs and to create an awareness of the role of the Education Programs Division, Department of Energy, as a facilitator and catalyst in establishing a national energy education communications network among community colleges and vocational schools.

The report, *Energy-Related Activities in Two-Year Postsecondary Vocational-Technical Institutions, A Representative Sampling by State (DOE/IR-0050)*, is available to a limited number of requests from:

U.S. Department of Energy
MS7E-054
Education Division
Washington, DC 20585

SOLAR

Solar energy is typical of the emerging energy fields that will have career implications. Projections regarding workforce needs are not readily available for many of the occupations that will evolve during this decade. To assist with occupational planning, the U.S. Department of Energy, Office of Education, Business and Labor Affairs, and Office of Solar Applications, conducted a study, *Solar Energy Employment Requirements 1978-1985.* The study describes characteristics of establishments engaged in solar energy work and the number and occupational distribution of persons working in solar energy activities in 1978.

The scope of the study includes all types of solar energy technologies and applications (space heating and cooling, water heating, industrial process heat, thermal power, ocean thermal conversion, photovoltaic conversion, wind conversion and biomass conversion), and all phases of work (research and development, manufacturing, marketing and distribution, and installation and maintenance).

It is estimated that approximately 2,000 establishments, both public and private were engaged in solar energy activities in 1978. Approximately three out of every four of these establishments were primarily working in solar space and water heating. The states with the most solar establishments were California (16 percent of the total), New York (8 percent), Massachusetts (7 percent), Colorado (4 percent), and Texas (4 percent).

Approximately 31 percent of the establishments were involved in the manufacture of solar collectors or other solar products. About 23 percent provided research and development services, and 18 percent provided architectural and engineering services. Twelve percent

were engaged in installation and 16 percent provided other solar-related services.

The total estimated number of persons working in solar energy in 1978 was 22,500. This figure represents all employees, both full and part-time. Unskilled workers made up the largest occupational group in commercial activities, and skilled workers made up the largest occupational group in installation. Engineers comprised the largest occupational group overall. Employers were asked to estimate the number of additional solar jobs which their establishment would add by 1981. The anticipated gain in solar employment was estimated to be 90 percent with the largest gains anticipated for skilled workers and technicians in the fields of manufacturing and construction. Only one out of every four employers thought their professional, technical or skilled craft employees performed tasks that were substantially different from those traditionally performed in nonsolar jobs. Where new skills were identified, special solar design, analysis and installation skills were most frequently mentioned by employers. Thus, there appears to be some need for persons trained in the design and analysis of new solar systems, and for persons trained in installing these systems. However, these employees must be capable of performing traditional as well as purely solar work.

Copies of the report, DOE/TIC-11154, are available from:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy $9.25; Microfiche $4.00.

ASSESSMENT

National Environmental/Energy Workforce Assessment

The Post-Secondary Education Profile, Phase II of the National Environmental/Energy Workforce Assessment, consists of 16 volumes which cover the following topics: air, energy, noise, pesticides, potable water, radiation, solid waste, wastewater, composite, and the private sector. The sample study was designed to provide an overview of environmentally related post-secondary education programs, their structure, representative course offerings, employment history of graduates, and the faculty organization.

The energy programs described in the sample are extremely diverse. Enrollments vary from fewer than 10 to more than 600 students. Nearly 60 percent of the students are in bachelors programs, about 25% are enrolled in associate degree programs, 13% in masters programs, and about 3% are in doctoral programs. Fewer than 5% of the students enrolled in energy programs are women.

Well-established programs in nuclear engineering, and mining petroleum and natural gas technology and engineering are defined. Additionally, there are unusual offerings in energy conversion, energy resources management, and others which represent recent innovative approaches to a broad spectrum of energy problems. Seven of the associate degree efforts either require or contain an active option of internships; 13 of the bachelor programs do so, as do nine of the masters programs. Several respondents singled out the applied study aspect as the most important component distinguishing their program from similar efforts.

The information included in the energy volume is evidence that people are doing more than just talking about our energy future. In addition of established curricula there are innovative efforts such as Cornell's College Program in Energy Conversion, the interdepartmental Energy Engineering and Policy program at the Polytechnic Institute of New York, the Energy Conversion and Resources Topical Program at Princeton, the undergraduate Energy Resources Management program of Lamar University, the graduate University of Pennsylvania Energy Management and Policy multidisciplinary program, and several others which represent recent innovative approaches.

The Associate level curricula included in this energy volume are of three basic types: Mining Technology, Petroleum Technology, and Nuclear Engineering/Safety Technology. Graduates are prepared for the following occupations:

- Entry Level Miner (Coal)
- Petroleum Engineer Technician
- Industrial Radiologist
- Radio-Chemistry Technician
- Health Physics Technician
- Property Analysis Technician (Petroleum)
- Reactor Operator
- Research Assistant
- Air Pollution Control Technician
- Environmental Tester/Analysts
- Drilling Technician
- Physical Science Technician

Bachelors-level curricula prepare students for the following occupations:

- Chemical Engineer
- Electrical Engineer
- Energy Efficiency Technician
- Energy Engineer
- Geophysicist
- Mechanical Engineer
- Metallurgist
- Mineralogist
- Mineral Processing Engineer
- Mining Engineer
- Mining Geologist
- Nuclear Engineer
- Nuclear Technician
- Petroleum Engineer
- Petroleum Geologist
- Physicist
- Power Reactor Operator
- Agronomist
- Bacteriologist
- Biochemist
- Biophysicist
- Chemist
- Ecologist
- Environmental Control Technologies
- Nuclear Plant Operator
- Strip Mine Inspector
- Solar Energy Technician
- Resource Conversion Technician
- Industrial Engineer
- Safety Engineer
- Petroleum Geologist Technician

Graduate level curricula prepare people for the above occupations and, in addition, the following:

- Environmental Physicist
- Mechanical Engineer (Conversion)
- Energy Policy Analyst
- Environmental Monitor Specialist
- Environmental Science Technician
- NRC License and Standards
- Electric Power Engineer
- Energy Management Systems Analyst
- Industrial Hygienist
- Oceanographer
- NRC Inspector

Most respondents felt that energy education will continue to grow and to proliferate at post-secondary institutions. Many observed that courses are becoming increasingly technical in emphasis and this trend will continue. Some viewed energy management and analysis as among the most crucially needed areas in the near future and, thus, most promising for employment opportunities. Others noted that programs with teaching and research commitment to alternative energy sources and technology are only now emerging.

Graduates of energy programs generally have highly sought after skills and have little difficulty finding employment. This condition is expected to continue and improve even as enrollments and subsequent graduates increase, simply because energy related expertise is in great demand.

The U.S. Environmental Protection Agency funded all three phases of the workforce assessment study.

National Environmental/Energy Workforce Assessment, Phase II, Post-Secondary Education Profile: Energy (ED 161 735) can be obtained from:

ERIC Document Reproduction Service (EDRS)
P.O. Box 190
Arlington, VA 22210

Microfiche, $0.83; paper copy, $21.32.

Phase I of this study focused on the development of workforce demand projections through 1982 for all public environmental agencies culminating in a

numerical profile of growth patterns and workforce needs at national and state levels.

Phase III contains program entries from junior colleges, vocational/technical training institutes, community colleges, four year colleges, and universities, as well as other training institutions. In total, 1,359 programs representing all 50 states, the District of Columbia, Puerto Rico and the Virgin Islands are represented.

The twelve-volume Phase III report is available for $55 from:

Graphic Printing
National Copy Center
P.O. Box 986
Iowa City, IA 52240

PATTERNS

The changing patterns of energy use expected to occur over the next several decades will also create a change in the national workforce. New technologies will require skills and knowledge not presently offered in traditional educational institutions. Careers will evolve from an emphasis on alternative energy sources. Modifications to the labor force will be needed in established energy fields as more efficient and environmentally compatible operations are established. Occupations that were not previously related to the energy field will take on major responsibilities. The U.S. Department of Energy offers two publications that can be of assistance to anyone concerned with selecting an energy occupation. *Professional Energy Careers* presents information on 20 various occupations related to the broad range of energy matters. A brief description of the field, suggestions for formal training, and additional sources of information are offered for each occupation. *Careers in Energy Industries* projects the demand for jobs in the exploration and extraction of coal, uranium, natural gas, and petroleum; petroleum refining; oil shale processing; production of synthetic fuels from coal; and the construction, operation, and maintenance of central station power plants. Although estimates of future requirements for expanded energy facilities must be viewed as tentative because of the diversity and complexity of the field, the employment trends, as listed in the pamphlet, can be useful for career planning purposes.

Copies of either publication can be obtained free of charge from:

Energy
P.O. Box 62
Oak Ridge, TN 37830

Those wishing to borrow negatives to print large quantities of these or other publications, should contact:

U.S. Department of Energy
Editorial Services (GA-343)
Office of Public Affairs
Washington, DC 20585

EEAC

Meeting Energy Workforce Needs was the theme of a conference sponsored by the U.S. Office of Education's Energy and Education Action Center in February, 1980. Nationally recognized authorities were invited to present papers in their respective fields. Presentations addressed topics such as the best available assessments of future job opportunities in energy-related occupations, curricula available, capabilities of schools, colleges and other training facilities to meet anticipated demands, effective guidance and counseling programs, and efforts to improve linkages between education, industry, government and labor.

William L. Smith, U.S. Commissioner of Education opened the conference with remarks about "Education's Role in Meeting Energy Workforce Needs." The following lists the agenda at the session:

Energy Development—Is There a Need for more People?—*Norman Seltzer*

The Future Workforce Requirements in Energy Producing Industries—*Neal H. Rosenthal*

The Politics of Energy and Jobs—*Richard L. Grossman*

Solar Energy Employment—*Girard W. Levy*

Training for Solar Jobs: A Follow-up of California CETA Programs and Their Graduates—*Barbara A. Burns, Bert Mason and Gail V. Mikasa*

Occupational and Training Requirements for Expanded Coal Production—*John B. Ostbo*

Preliminary Forecast of Likely U.S. Energy Consumption/Production Balances for 1985 and 2000 by States—*J. F. Gustaferro*

Update of Employment Trends in Nuclear Power Industries—*Larry M. Blair*

Forecasting Construction Labor Requirements for Powerplants—*William F. Hahn*

Strengths and Pitfalls in Doing a Needs Assessment in Emerging Energy Technologists—*Marcus C. King*

Training Programs and Advanced Education in Solar Energy—*Kevin O'Connor*

Workforce Training Implications of an Empirical Survey of Energy Curricula—*Ethel Simon-McWilliams*

Counseling for Career Opportunities in Energy-Related Industries—*Mayme R. Crowell*

The Development and Dissemination of Career Information for Student/Workers—*Russell B. Flanders*

Orienting America's Youth Towards Future Energy Careers—*Ann L. Borden*

Career Education and the Energy Crisis—*Kenneth B. Hoyt*

Opportunities for Women in Energy—*Mary Lou Randour*

Linkage Efforts Among the States—*Edith M. Petrock*

Industry and Linkage Building—*George H. Lawrence*

Improving Linkages Among Governmental Organizational Entities—*Wilton Anderson*

A Model Needs Assessment—*Michael J. Nastick*

Renewable Energy and Employment: Decentralized Energy and Jobs in the 80's—*Scott Sklar*

A Profile of Energy Education Programs—*Jack Seum*

Employment, Education, and Recent Legislation—*Wayne Stevenson*

Vocational and Adult Education-Energy and the 80's—*Daniel Dunham*

Broad-Based Curriculum for Training Energy Conservation and-Use Technicians—*Michael E. Blackmon*

Project EFFECT: Energy for the Future: Education, Conservation, Training — *Gail S. Dowdy*

Energy Education and Elementary and Secondary Schools—*Shirley J. Hansen*

Energy and Jobs for the Future—*Rafael Fermoselle*

Training Technicians for Coal-Fired Power Plants—*Bonnie F. Rinard*

Training Programs of a Public Utility—*Sondra J. Gillice*

Energy, Education and Economic Development—*Ann M. Martin*

Energy Impacts on Our Health Delivery System—*Gordon W. Berg*

Copies of the proceedings, cloth bound, 336 pages, titled, *Meeting Energy Workforce Needs, Determining Education and Training Requirements* can be obtained from:

Information Dynamics, Inc.
111 Claybrook Drive
Silver Spring, MD 20902

The cost is $20.00 if remuneration accompanies the order. Otherwise, add $1.50 for handling.

GWAZDA

Energy Occupations Handbook, by Edward Gwazda and others, is a student handbook which includes surveys of energy fields and occupations, career guidance activities for energy-career decision making and choice, and resources for energy career education, including state and national educational programs, selected student and professional readings, audio-visual and curriculum materials and a directory of related businesses and industries. Over 60 different fields and 60 different occupations are described in some detail. Career guidance sections provide practical advice for selecting, preparing for, and obtaining employment in energy-related fields.

The publication was prepared by the Center for Coastal and Environmental Studies, Rutgers University, for the New

Jersey Department of Education, Division of Vocational Education and Career Preparation, under Section 123 of PL 94-482. Individuals may order the handbook by including a check or money order for $6.00 plus $1.25 for postage and handling from:

New Jersey Vocational-Technical Curriculum Laboratory Building
4103 Kilmer Campus
Rutgers-The State University of New Jersey
New Brunswick, NJ 08903

It may be located in ERIC microfiche collections as ED 179 825.

IDAHO

Traditionally, the educational systems of our country have been called on to explore and resolve societal problems. The energy situation is a unique opportunity for educators since it reflects a complex set of problems that requires changes in values, attitudes and lifestyles. The *Idaho Energy Conservation Resource Guide for Career Education* was prepared to assist teachers to incorporate energy concerns within the school curriculum. It is intended to provide a basic framework to increase students' understanding of four goal oriented units: (1) Natural laws limit energy availability; (2) Energy consumption affects both man and his environment; (3) Human values and attitudes affect energy use; and (4) Energy consumption is necessary to maintain our life style.

Understanding the importance of energy to one's career is an essential part of developing a realistic view of the world. The following concepts, activities and skills are included in this guide for students in grades 7-12:

1. Values clarification
2. Decision making
3. Occupational skills development
4. Self awareness
5. Community awareness
6. Economic awareness
7. Occupational awareness
8. Future awareness

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ED 127 431 CE 007 570
Federal Agencies for Career Education Services.
Office of Education (DHEW), Washington, D.C. Pub Date Jan 76
Note—48p.
EDRS Price MF-$0.83 PC-$3.32 Plus Postage.
Descriptors—*Career Education, *Educational Development, Educational Legislation, Educationally Disadvantaged, *Educational Opportunities, Federal Aid, *Federal Programs, Government Publications, Program Guides, *Resource Guides
This guide to federal government resources contains two major parts: (1) a set of descriptions of 38 federal programs that offer various types of resources for career education, and (2) a set of indices to help the practitioner use these programs. Indices include the following categories for each program: Program title, description, relationship to career education, financial assistance, publications, and where to get help. Stated limitations to the guide are that it does not promise to include all federal government programs that may be useful in career education, and it does not present detailed information on how to obtain funding from the programs described. It is suggested that the practitioner contact the programs directly for this information. (TA)

ED 142 782 CE 011 946
Brooking, Walter J.
Energy Related Technology Programs at the Non-Baccalaureate Postsecondary Level.
Pub Date 6 Jul 77
Note—27p.; Speech presented at a National Invitations Conference sponsored by the Energy Research and Development Administration's Division of Labor Relations and the American Association of Community and Junior Colleges, Atlanta, Georgia (October 27, 1976.)
EDRS Price MF-$0.83 PC-$3.32 Plus Postage.
Descriptors—*Associate Degrees, Community Colleges, Educational Needs, *Energy, Junior colleges, Manpower Needs, Needs Assessment, Petroleum Industry, Program Development, *Program Planning, Solar Radiation, *Technical Education, *Technical Institutes, Technical Occupations, Technology
Identifiers—Coal, Geothermal Energy, Nuclear Energy
Guidelines are presented for institution administrators considering the initiation of programs to train energy-related technicians at the associate degree level. Two essential preliminary steps are outlined: Acquiring and analyzing all available information about the proposed field including national legislation and surveying the probable need for technicians in the area served by the institution. Study questions for the decision to develop a curriculum are followed by the caution that introducing and refining a new program takes a minimum of five years and also involves determining the need for additional facilities and the availability of qualified instructors. Potential areas for program development are then discussed individually for energy-related technicians in coal mining, beneficiation, and processing; petroleum extraction and refining; nuclear power production; solar energy; conversion of wind, geothermal or tidal energy; and possibly a new type of technician, the energy monitoring or control technician. A list of names and addresses of junior colleges with existing and planned energy-related technology programs is attached for each of four program areas: Coal, petroleum, nuclear, and solar. (BL)

ED 142 794 CE 011 948
Moore, Allen B.
Energy Problems Provide Job Opportunities.
Ohio State Univ., Columbus. Center for Vocational Education.
Spons Agency—Bureau of Occupational and Adult Education (DHEW/OE), Washington, D.C.
Pub Date 1 Jul 77
Note—15p.
EDRS Price MF-$0.83 PC-$1.82 Plus Postage.
Descriptors—Demand Occupations, Depleted Resources, *Employment opportunities, *Employment Projections, *Energy Conservation, Literature Reviews, Natural Resources, *Vocational Education
In response to the problems created by a diminishing energy supply but an increasing energy demand, this second in a series of national reports studies the linkage of vocational education and energy. Through an examination of selected literature with reference to types of energy resources, the author identifies the emerging occupations related to the development of alternative energy sources and considers the relevance of these occupations to vocational education. (BM)

ED 166 028 SE 026 332
Grossman, Richard Daneker, Gail
Guide to Jobs and Energy.
Pub Date—Jan 78
Note—25p.; Not available in hard copy due to copyright restrictions
Available from—Environmentalists for Full Employment, 1101 Vermont Avenue, N.W., Room 305, Washington, D.C. 20005 ($3.00)
EDRS Price MF-$0.83 Plus Postage. PC Not Available from EDRS.
Descriptors—Economic Climate, *Economics, Efficiency, *Employment, Employment Level, Employment Opportunities, Employment Potential, *Energy, *Energy Conservation, Environmental Education, Jobs, Politics, Solar Radiation
This document is a review of the work being done in the area of energy and the economy. The authors believe that increased energy efficiency, plus more jobs than the large scale system scenario, which corporate energy interests, many industrialists, and some government agencies, are promoting. The document includes the following sections: (1) energy and the economy; (2) substitution of energy for labor; (3) productivity and jobs; (4) energy growth and prosperity-the myth; (5) energy inefficiency and waste; (6) capital investment; (7) energy efficiency and jobs; (8) solar, wind, and biomass conversions; and (9) the politics of solar energy. Extensive footnotes are given. (TM)

ED 167 786 CE 020 237
Bartley, Hugh J. And Others
Career Fields for Inspection and Enforcement Personnel
General Research Corp., McLean, Va.
Spons Agency—Nuclear Regulatory Commission, Washington, D.C. Office of Inspection and Enforcement.
Report No.—NUREG-CR-0042
Pub Date—Oct 78
Contract—NRC-05-77-142
Note—135p.; Not available in hard copy due to reproducibility problems
Available from—National Technical Information Service, Springfield, Virginia 22161 ($6.50, printed copy; $3.00, microfiche)
Pub Type—Reports - Descriptive (141)
EDRS Price - MF-$0.83 Plus Postage. PC Not Available from EDRS.
Descriptors—Building Trades, Career Ladders, *Career Opportunities, Construction Needs, Educational Needs, *Employment Opportunities, *Employment Qualifications, *Energy, Environmental Technicians, Fuels, Health Occupations,

Inspection, Investigations, *Job Development, *Occupational Mobility, Radiation, Safety, Security Personnel, Standards, Training
Identifiers—*Nuclear Power, Reactor Operations
This document is the General Research Corporation (GRC) report on Task II, which called for the development of career fields for headquarters and regional positions of the U.S. Nuclear Regulatory Commission Office of Inspection and Enforcement (NRC/IE). GRC examined the data of Task I (development of qualifications requirements) for commonality of knowledge and performance, postulated career fields as a result of that examination, and tested and revised those career fields by more extensive examination. Proposed as a result of this are four career fields: construction-vendor, health physics, reactor operations, and safeguards; and two "career ladders"; fuel facilities and investigation. (The term "career ladder" was chosen to describe the relatively narrow patterns of positions open to its members.) All career fields include subfields, which are described in full in the report. In addition to recommending acceptance of these career fields, this document proposes the combination of certain subfields, the retitling of some positions, and the adoption of a standard nomenclature for all NRC/IE positions. (Author)

ED 170 123 SE 027 539
Study Guide for Fundamentals of Solar Heating: A Correspondence Course for the Airconditioning Industry.
Sheet Metal and Air Conditioning Contractors National Association. Vienna, Va.
Spons Agency—Department of Energy, Washington, D.C.
Report No.—HCP/M-4038-02
Pub Date—Jan 78
Contract—EG-77-C-01-4038
Note—115p.; For related document, see SE 027 538
Available from—National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161 ($6.50)
Pub Type—Guides - Classroom - Learner (051)
EDRS Price - MF-$0.83 PC-$7.32 Plus Postage
Descriptors—Adult Education, *Adult Vocational Education, *Energy, *Heating, *Solar Radiation, Thermal Environment.
This study guide groups eleven lessons into four study units. The first discusses the development and basic concepts of solar heating. The second unit deals with the nomenclature of the solar heating system. The third study unit covers sizing of the solar heating system to meet demand and discusses the operation of the total system. The fourth unit presents learning materials concerning installation and servicing of solar assisted heating systems. There are review tests and unit examinations structured for assistance in reviewing the material and in integrating new information with that learned previously. (Author/RE)

ED 170 123 SE 027 540
Energy Conservation Workshop — Training Requirements for Technicians (Atlanta, Georgia, October 30-November 1, 1977).
Department of Energy, Washington, D.C. Div. of Power Systems.
Pub Date—Mar 78
Note—54p.; Contains occasional light type
Available from—National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161 ($5.25)
Pub Type—Reports — Descriptive (141)
EDRS Price - MF - $0.83 PC-$14.32 Plus Postage
Descriptors—Community Colleges, Energy, *Energy Conservation, *Fuel Consumption, *Higher Education, Postsecondary Education, Socioeconomic Influences, *Technical Education, Technological Advancement, *Technology Transfer, *Vocational Education, Workshops.
This workshop was convened to study the training requirements of skilled technicians who will be required to install, operate, and maintain the advanced equipment and systems being developed by the Division of Power Systems of the Department of Energy (DOE). Community college educators and DOE technology program administrators were brought together in a workshop setting for discussions on the status of current programs, future needs, and ways needs could be solved. Included in the document are sections containing conclusions and recommendations of the conference, background of the conference, and a conference report. Appendices include a list of workshop participants, a description of the DOE's Division of Power Systems, and a brief summary of some of the characteristics of the junior college and community college system. (RH)

ED 182 137 SE 029 778
Carter, Lee And Others
Idaho Energy Conservation Resource Guide for Industrial Arts Education.
Adaho State Dept. of Education, Boise.; Idaho State Office of Energy, Boise.; Idaho Univ., Moscow.
Spons Agency—Department of Energy, Washington, D.C.
Pub Date—79
Note—145p.; For related documents, see SE 029 772-777. Contains light and broken type.
Pub Type—Guides - Classroom - Teacher (052)
EDRS Price - MF - $0.83 PC-$9.32 Plus Postage.
Descriptors—*Class Activities, *Energy, *Energy Conservation, Fuel Consumption, Fuels, Heating, *Industrial Arts, Interdisciplinary Approach, Mathematics Education, *Science Education, Secondary Education, Solar Radiation
This resource guide was prepared to assist teachers in incorporating energy concerns within the school curriculum. It is intended to provide a basic framework of objectives for different subject areas and to provide examples of activities for teaching towards the stated objectives. Resources are listed to aid the teacher in developing additional activities. The resource guide is based on the assumption that its contents will provide a starting point and that teachers will go further in devising lessons in energy instruction. (Author)

UMI

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EJ 148 083 EA 507 759
Coal Week: Answering a Community's Educational Need Zanella, Richard E., *Phi Delta Kappan*, v58 n4, pp335-337, Dec 76
*Occupational Information, *Career Awareness, *Community Involvement, Program Descriptions, Senior High Schools
A week-long special program introduced the students of Northern Cambria High School to their coal-mining heritage and involved members of the coal industry and of the community. (IRT)

EJ 167 232 CE 506 802
Energy War Is Generating Jobs Fiester, Kenneth, *Worklife*, v2 n10, pp 14-20, Oct 77
*Employment Opportunities, *Energy Conservation, *Job Development, *Manpower Utilization, *Building Improvement, *Fuel Consumption, Solar Radiation, Fuels, Employment Projections, Climate Control, [Insulation]
Describes various energy-related projects and legislation, with new job estimates, to improve or design buildings and methods to reduce the annual growth in energy consumption by reducing gasoline consumption, cutting oil imports, increasing coal production, insulating buildings, and installing solar energy devices. (MF)
Reprint Available: UMI

EJ 167 233 CE 506 803
Solar Technician Program Blows Hot Ziegler, Peg Moran, *Worklife*, v2 n10, pp21-24, Oct 77
*Solar Radiation, *Building Improvement, *Energy Conservation, *Project Training Methods, Heating, Trainees, Job Placement, Post Secondary Education, Technical Education, Program Descriptions, [*Solar Energy Technicians], [Comprehensive Employment and Training Act, CETA, California]
A training program for solar heating technicians was initiated at Sonoma State College's School of Environmental Studies for CETA applicants. Among the projects designed and built were a solar alternative energy center, a solar hot water system, and a solar greenhouse. (MF)
Reprint Available: UMI

EJ 178 800 CE 507 402
Energy and Occupational Education Ansell, Sherman D., *Wisconsin Vocational Educator*, v2 n3, pp7-9, Mar 78
*Energy Conservation, *Educational Needs, *Curriculum Development, Industrial Technology, Educational Planning, Vocational Education, Vocational Retraining, Employment Protential, [*Emerging Occupations, *Energy Technology], [Energy Related Industries, Wisconsin]
Examines the potential changes that dislocations in energy sources and uses would have on vocational training in Wisconsin and the new energy technologies which will require curriculum change or development. (MF)
Reprint Available: UMI

EJ 184 512 CE 507 773
Energy Education: Teaching for the Future Gierke, C. David, *Man/Society/Technology*, v37 n8, pp6-9, May-Jun 78
*Energy Conservation, *Changing Attitudes, *Industrial Arts, Conservation (Environment), Curriculum, Power Mechanics, Industrial Education, Senior High Schools, [*Energy Technology], [Energy Sources]
A major challenge to education for the future involves energy attitude modification, and industrial arts is best prepared to institute energy education, says the author. He outlines the energy technology curriculum at East Senior High School, West Seneca, New York, and includes photographs from the solar and wind power course. (MF)
Reprint Available: UMI

EJ 198 168 CE 508 265
Energy Vocational Instructions. Fowler, John M.; Kryger, King *VocEd;* v54 n1 p41-43 Jan 1979 (Reprint: UMI)
Pub Type: Guides—Classroom—Teacher (052); Opinion Papers (120)
Descriptors: *Conservation Education; *Conservation (Environment); Curriculum Development; Ecological Factors; *Economics Factors; Educational Needs; Employment Opportunities; Energy; *Energy Conservation; Fused Curriculum; *Interdisciplinary Approach; Social Environment; *Vocational Education
Identifiers: *Energy Education
From their experience in the National Science Teachers Association's Project for an Energy-Enriched Curriculum, the authors discuss short-range and long-range energy problems and the multidisciplinary responses that education must make to these problems. Energy/environment/economics topics should be infused into the curriculum and vocational students prepared for environmental conservation careers. (MF)

EJ 198 171 CE 508 268
Training for a Place in the Sun. Fillippini, W.L. *VocEd;* v54 n1 p51-53 Jan 1979 (Reprint: UMI)
Pub Type: Reports—Descriptive (141)
Descriptors: *Apprenticeships; Building Trades; Curriculum Development; *Energy Conservation; Inservice Teacher Education; *Job Skills; Postsecondary Education; School Industry Relationship; *Sheet Metal Workers; *Solar Radiation; Training Techniques
To train sheet metal workers in energy conservation technology, the National Training Fund (NTF) of the Sheet Metal and Air Conditioning Industry collaborated with universities in developing their apprenticeship curricula on solar-powered environmental

systems, a solar air system training film, and NTF instructor training courses and workshops. (MF)

EJ 190 172 CE 508 269
Energy Extension Service: A New National Resource.
VocEd; v54 n1 p54-55 Jan 1979 (Reprint: UMI)
Pub Type: Reports—Descriptive (141)
Descriptors: Conservation Education; Consumer Education; Curriculum Development; *Energy Conservation; Extension Education; Federal Aid; Field Check; *Government School Relationship; *Outreach Programs; Program Development; State Programs; *University Extension; *Utilities; Vocational Schools
Identifiers: *Energy Education; *Energy Extension Service
The ten-state university extension pilot program of the Energy Extension Service, United States Department of Energy, provides training through the state vocational education system for staff from utilities, community agencies, and local government to make on-site energy audits and encourage conservation by small energy users. (MF)

EJ 202 780 CE 508 495
Solar Grants Spot Training and Jobs. Owen, Walter
Worklife; v4 n1 p8-15 Jan 1979 (Reprint: UMI)
Descriptors: *Building Improvement; Community Services; Demonstration Projects; *Employment Programs; *Energy Conservation; Federal Aid; *Heat Recovery; *Job Training; *Solar Radiation
Identifiers: Comprehensive Employment Training Act 1973; *Solar Utilization Economic Development Employment
Employment and training in solar installation work is provided by fifteen Solar Utilization/Economic Development and Employment (SUEDE) demonstration projects funded by the United States Departments of Labor and Energy and the Community Services Administration. The article describes the projects and the types of work. (MF)

EJ 203 736 SE 525 213
Technical Education to Meet New Demands in Energy. Hull, Daniel M. *Engineering Education;* v69 n8 p798-802 May 1979 (Reprint: UMI)
Descriptors: *Curriculum Design: Curriculum Development; *Curriculum Evaluation; *Energy Conservation; *Engineering Education; Environmental Technicians; Program Descriptions; * Technical Education
A curriculum research and development project is described. The project, sponsored by the U.S. Office of Education, is intended to develop and test a curriculum for training energy conservation and use technicians. (BB)

NTIS.

Copies of the documents included in the following list are available in paper copy and microfiche from:

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Current prices are listed; however, as with all publishing services, the prices are subject to change.

Proceedings of the First National Workforce on Energy Efficiency Education Through Technology Transfer. K. C. Cohen. Department of Energy, Washington, DC. Div. of Power Systems. 1977, 110p. CONF-771245-Price code: PC-$9.00/MF-$3.50.
PROCEED (Program for Continuing Engineering Education), with its ability to be used in traditional modes of continuing engineering education as well as to provide a new approach to updating and problem-solving on the job, is an effort which the U.S. Department of Energy should encourage and evaluate carefully in a variety of ways, especially in areas under its aegis such as energy conservation, alternative energy sources, and associated technologies. A number of specific recommendations were made to the Project as well as to the Department of Energy. Seven speeches given at the workshop were: The National Energy Problem and the Federal Response, Dr. John A. Belding; Energy Conservation Education—Major Considerations, Professor Elias P. Gyftopoulos; False Images in Engineering Education, Professor Myron Tribus; Effective Methods of Delivering Appropriate Information—A Status Report, Dr. Harvey J. Brudner; Project PROCEED—Developmental History, Professor Lawrence B. Evans; Project PROCEED—Its Learning Design, Professor Karen C. Cohen; and Project PROCEED—How It Works, Dr. C. Michael Mohr. (ERA citation 04:000839)

Energy Resources Technical Training and Development Programs for American Indians. R. E. Cameron. and W. S. White. Argonne National Lab., IL. Aug 78, 26p. ANL/EIS-10 Price code: PC-$6.00/MF-$3.50.
Because of the energy resources located on Native American owned lands, it is pertinent that the tribes on these reservations receive information, training, and technical assistance concerning energy and the environment and the decisions that must be made about energy-resource development. In the past, attempts to enlist Indians in technical-assistance programs met with little success because teaching methods seldom incorporated program planning by both tribal leaders and the technical training staff. Several technical-assistance programs given on reservations in the central and western parts of the country were conducted by Argonne National Lab—programs that stressed practical, on-the-job experience through lecture, laboratory, and field studies. Each program was designed by ANL and tribal leaders to fit the needs and concerns of a particular tribe for its environment. The individual programs met with an impressive degree of success; they also prompted several Indians to pursue this type of education further at ANL and local Indian community colleges and to obtain funds for energy projects. Despite the positive feedback, several difficulties were encountered. Among them are the necessity to continually modify the programs to fit diverse tribal needs, to diminish politically motivated interference, and to increase portions of the funding to involve more Native Americans. (ERA citation 04:000818)

Plumbing Engineers Solar Energy Handbook, Southern California Region. California Univ., Livermore, Lawrence Livermore Lab., 1978, 320p. LLL/M-083 (Rev. 1) Price code: PC-$17.00/MF-$3.50.
This handbook was prepared by the Technology Applications Group, LLL, for the "Solar Workshop for the Plumbing and HVAC Engineer," held at the Marina City Club, Marina del Rey, California on March 10 and 11, 1978. Discussed in order are solar components and systems (collectors, storage, service hot water systems, space heating with liquid and air systems, space cooling, heat pumps and controls;) computer programs for system optimization; local solar and weather data; a description of buildings and plants in Southern California applying solar technology; current Federal and California solar legislation; standards, codes and performance testing information; a listing of manufacturers, distributors, and professional services available in the Southern California region; and information access. Finally, the last section provides solar design check lists for those engineers who wish to design their own systems. (ERA citation 03:0522479)

Energy-Related Scientists and Engineers: Statistical Profile from the NSF National Sample, 1976. M. G. Finn. and J. E. Rall. Oak Ridge Associated Universities, Inc., Tenn. May 78, 51p. ORAU-143 Price code: PC-$7.00/MF-$3.50.
Characteristics of experienced energy-related scientists and engineers in 1976 and changes in this group from 1974 to 1976 are described. The data come from the 1976 Survey of Natural and Social Scientists and Engineers, conducted by the Bureau of the Census for the National Science Foundation. There were 114,895 experienced scientists and engineers indicating that their work was energy-related in 1976, more than in 1974. Unemployment, low at only 1.9 percent of all experienced scientists and engineers, was equally low for energy-related scientists and even for energy-related engineers. Females make up 4.8 percent of all experienced scientists and engineers but only 0.8 percent of energy-related scientists and engineers. Energy-related scientists (but not engineers) tend to be substantially older than scientists not reporting that their work was energy-related. Compared with experienced scientists and engineers whose work was not energy-related, the energy-related earned higher salaries, were more often employed by private business, more often employed as managers, and were rather heavily concentrated in the West South central region. 1 figure, 11 tables. (ERA citation 03:048064)

Energy Education Training Center – Feasibility Study. George R. Mead. Eastern Oregon Community Development Council, La Grande. June 78, 300p. CSA/LN-2286. PB-285 910/6WE Price code: PC-$16.00/MF-$3.50.
A study was made of the impact of rising energy prices on the poor and near poor, especially in the states of Oregon and Washington. The creation of an Energy Education Training Center is proposed to act as an agent in bringing energy conservation measures and technological innovations such as solar power to the local level.

Guide for Preparation of Proposals for Faculty Development Projects in Energy: 1979. Department of Energy, Washington, DC. Div. of Education Programs. Apr 78, 12p. DOE/IR-0010 Price code: PC-$5.00/MF-$3.50.
DOE will provide support through this Faculty Development Program to colleges and universities for projects aimed at the development of high school and college faculty understanding of important subject matter relating to the development, conservation, and utilitzation of U.S. energy resources. By assisting in the improvement of energy education in the nation's schools, the program plays a significant role in the judicious and orderly development of U.S. energy resources. The specific objectives of the program are: to improve teachers' knowledge of energy-related subject matter and to develop and maintain communication and cooperation between high school, college, and university teachers on energy-related matters. This guide is provided to aid in submitting proposal requests. (ERA citation 03:048050)

Coop

The Department of Energy (DOE) encourages the introduction of new energy technology, information and materials into all appropriate educational programs and curricula, and the cooperative exchange of technical manpower and ideas between DOE Laboratories/Technology Centers and the academic community.

Sponsored Research in the Sciences and Engineering

Through its support of basic research and development at government laboratories and universities, DOE indirectly contributes significantly to the basic training of scientists and engineers in field relevant to DOE's mission. A major part of the professional manpower development under the DOE research program, thus, takes place indirectly through the temporary employment of graduate students as research assistants of research projects at universities and DOE Laboratories and Energy Technology Centers. Inquiries concerning opportunities in these research programs should be made directly to the personnel offices of the Laboratory or Technology Center or in

the case of a university contractor with the responsible professor or principal investigator.

I. Faculty Research Participation

Summer or academic year appointments are available with a general limitation of 12 months total under the program. Most appointments are made for the summer period; however, sabbatical year appointments are also considered on a partial support basis. The program is principally one of research, working with a laboratory staff member on a problem of mutual interest. Applicants must be full time faculty members of an accredited college or university with a commitment to continue teaching and or research as a career.

II. Student Research Participation

This activity provides qualified junior/senior level undergraduate science and engineering students the opportunity to participate in research, development and demonstration programs at approved DOE Laboratories of Energy Technology centers. Most, though not all, appointments are for the summer period.

III. Laboratory Graduate Research Participation

Selected full-time graduate students enrolled in accredited universities may receive appointments of up to one year—renewable to a maximum of three years-to carry out their Ph.D. or master's thesis research in residence at a DOE Laboratory or Energy Technology Center. The purpose of the program is to provide opportunities for graduate students to carry out their dissertation requirements when the necessary facilities or resources are not available on campus.

IV. Thesis Parts Research Participation

This activity provides opportunities for full-time graduate students to conduct short-term portions of their research-a few days to several weeks-at a DOE facility having a special resource or equipment required for the research.

In addition to the research participation opportunities, there are several supplemental, short term educational and training activities designed to complement and support training needs and energy curriculum requirements. Faculty institutes, workshops, conferences, visiting lecturers, and faculty research visits are periodically offered. For information on specific requirements and the address of Laboratory and Technology Centers, write:

U.S. Department of Energy
Office of Energy Research
University and Industry Programs Division
Washington, DC 20585

Information on curricula needs and specific energy programs implemented in community and junior colleges is available from the Energy Communications Center, American Association of Community and Junior Colleges (AACJC), 1 Dupont Circle, Washington, DC 20036. The AACJC developed the following energy-related materials and activities.

Energy-Related Technology in Community and Junior Colleges, a study published in July, 1976 for ERDA, written by John R. Doggette of Oak Ridge Associated Universities, Oak Ridge, Tennessee in cooperation with AACJC.

AACJC Office of Governmental Relations conducted a survey in spring 1978 to assess variety and scope of energy technician courses and curricula offered nationally in community colleges. The report is available at AACJC: *A Survey of Energy Programs in Two-Year Colleges and Technical Institutes.*

An appropriate technology roundtable was held at AACJC on July 19-20, 1979 with National Science Foundation support to pursue questions: Is there a role for community college in appropriate technology? Does the role include instruction, information, and/or catalyst for action? (Report available at AACJC: *Community College and Appropriate Technology.)*

In the summer 1979, the Energy Forums project was funded by the National Endowment for the Humanities and the Department of Energy with additional collaboration with Ted Turner's Atlanta Super Station and others. Currently, more than 450 colleges are participating. Coordinating colleges in each of the 10 federal regions were selected. The project purpose is to help local citizens understand energy conditions, the current and future impacts of energy costs and shortages on their lives, and the adjustments in life style which may be required. The program offers opportunities for citizens to express their ideas and concerns. Materials are available at AACJC.

In August 1979, the Department of Energy funded the Energy Communications Center, a one-year program designed to collect and disseminate information concerning community college energy programming including curriculum, courses, continuing education, construction, retrofitting (thermal drapes, double-pane windows, insulation, computer control of facility environment, lighting, double foyers, etc.) and others. The project will produce the following monographs:

A. *Energy Curriculum Guide*
B. *Energy Conservation-Community College Approaches*

Both will be available at AACJC in 1980. The Center is also working with the DOE, Office of Consumer Affairs on the recently funded *Alcohol Fuels Production Workshops* program. The successful applicants in this competition (30 of 40 are two-year postsecondary institutions) are identified in the January 1980 issue of *The Energy Consumer.* The Center is supporting Colby Community College, Colby, Kansas in producing a training manual and videotapes on alcohol fuels production.

National Center for Resource Development (an AACJC affiliated council) is producing a program that will produce a guide to community college energy program funding sources, a booklet of case studies, and recommendations for future activities.

Scoreboard

A project that exemplifies the type of energy education effort that can directly influence homeowners is *The Energy Scorecard*, developed by Energy Information Associates for the Colorado Energy Extension Service. About 50,000 score cards were distributed throughout the state to enable individual homeowners to audit their energy use in three areas; transportation, the home and appliances. Energy points are assessed for how individuals used energy over the past year. Energy saving points are also awarded based on energy conservation steps taken within the past three months. Each section has a summary at the end to total up scores and compare them to the average Colorado energy user. A Teacher's Guide was subsequently developed to encourage junior high school teachers to incorporate energy education within thier classrooms. Ten workshops with 40 teachers enrolled in each have been conducted to assist implementation of the program. Classroom activities for home economics, mathematics, science and social studies are included in the Guide. A limited number of copies are available and can be obtained by contacting:

Robert P. Brown, Director
Colorado Energy Extension Service
1600 Downing Street
Denver, Co 80218.

Managing

Managing Your Home's Energy Dollar, An Energy Management Workbook for the Homeowner, was distributed to homeowners in several Colorado counties to encourage energy conservation. The easy-to-read 37 page publication covers such topics as reading utility meters, monitoring energy use, suggestions to make the home more energy efficient, decisions about conservation products, and comparing your energy use. Sixteen workshops were held to assist homeowners to follow the guidelines in the workbook. Copies may be obtained, while the supply lasts, from:

Project HEAT
Arapahoe County
5334 S. Prince Street
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Environmental Education

Energy Education Programs: Elementary School Programs and Resources
H. L. Coon and J. F. Disinger, compilers ED 183 386

Fourteen energy education programs in elementary schools are described. An annotated bibliography of energy materials announced in "Resources in Education" and available from ERIC is included.

Energy Education Programs: High School Programs and Resources
H. L. Coon and J. F. Disinger, compilers ED 193 381

Methods by which selected high schools have integrated energy education into classrooms are described. The 12 case studies contain information about resources used. An annotated bibliography includes information about other curriculum materials.

Water Quality Instructional Resources Information System (IRIS): A Compilation of Abstracts to Water Quality and Water Resources Materials
ED 182 111

Over 1,700 abstracts of print and non-print materials related to water quality and water resources education are contained in this compilation. Entries are included from all levels of governmental sources, private concerns, and educational institutions.

Current Issues V: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Eighth Annual Conference of the National Association of Environmental Education.
Arthur B. Sacks and Craig B. Davis, editors ED 180 822

Proceedings are presented in two major sections. Section I contains 12 papers based on original research and thought, providing historical perspective and future projections. Section II contains four descriptive papers and program reviews, intended to be useful and of interest to environmental educators.

Values Activities in Environmental Education
Mary Lynne Bowman ED 182 118

Class activities for students in grades K-12 provide a variety of approaches to values discussion and clarification. Content involved includes single subject areas or combinations of science, mathematics, social studies, language arts, and fine arts.

An Annotated Bibliography of Environmental Communication Research and Commentary: 1969-1979
Renee Guillierie and A. Clay Schoenfeld ED 184 852

Significant literature of the environmental communication field is identified and reviewed. Included are (1) background on environmental communication, (2) strategy and tactics of the environmental communication literature review, (3) an index, (4) journal articles, and (5) book abstracts.

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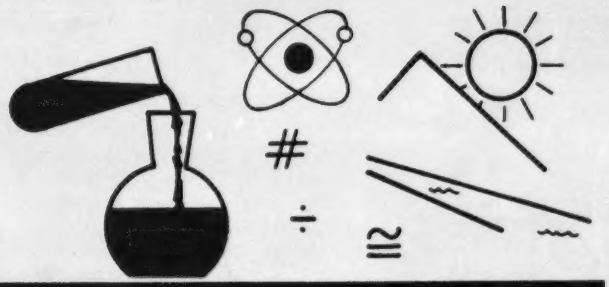

Safety in The Science Classroom

Editor's Comments

The third issue of the ERIC/SMEAC information bulletin for 1980 is focused on information related to the topic of safety in the science classroom. Safety is discussed as it relates to teacher responsibility; general safety procedures in the science laboratory; safety procedures for use of chemicals, of microorganisms, of plants and animals, of electricity, of lasers, and of model rockets. References are also provided for sources cited in the bulletin as well as additional useful references for science teachers.

Readers wishing copies of the materials identified in the bibliography and related references sections of this bulletin should check the appropriate issues of *Resources in Education* (RIE) for ordering information for documents having an ED number. Reprints of some of the journal articles are available from University Microfilms International. Ordering information for UMI reprints is found in *Current Index to Journals in Education* (CIJE). Sufficient publication information is provided for those materials which are not a part of the ERIC system to enable interested readers to write for copies or for additional ordering information. These reference materials are *not* available from the ERIC Clearinghouse for Science, Mathematics and Environmental Education.

This material on safety in the science classroom and laboratory was written for this issue by Gary Sweitzer, Graduate Research Associate and Information Analyst, Science Education, ERIC/SMEAC.

Who is responsible for the safety of the student in the classroom?

Even though teachers are employed by local school boards and may be directly responsible to building principals and/or area supervisors, it has been ruled that the teacher is not the "servant" or "agent" of the school district in the legal sense of those terms (Brown & Brown, 1969). Therefore, it is the teacher who is directly responsible for the safety of his/her students and it is unlikely that any court would transfer responsibility for a student injury from the teacher to his/her employer. However, before a teacher can be held personally liable for any injuries to students it must be proved that the teacher acted in an illegal or improper manner or neglected to take proper action. This improper conduct could include performance of an act that puts pupils in a hazardous position as well as failure to take appropriate action for student protection. It is the responsibility of the teacher to exercise "reasonable care" in the performance of his/her duties. Reasonable care indicates that the teacher must foresee possible dangers, at least to the extent that any reasonably prudent person would.

What must be done by a science teacher to demonstrate reasonable care for student safety?

As is the case with many aspects of instruction, the planning phase is very important in establishing reasonable care. In planning teacher demonstrations or student experiments, the activity should be examined against a criterion of educational merit versus hazard potential. Once the hazards have been identified, steps must be taken to alert students to the hazards and to make them aware of the proper safety procedures.

A simple posting of instructions or rules has been held by the courts to be insufficient. To demonstrate reasonable care the teacher must remind the students of the general safety instructions and provide any appropriate specific instructions before each activity. The teacher cannot rely on general instructions given at an earlier time. During the course of the activity it is the teacher's responsibility to provide adequate supervision including the selection and use of the designated chemicals. A teacher who must leave the room for a chemical or item of equipment that was inadvertently omitted leaves himself/herself open to charges of negligence.

The concept of reasonable care also extends to activities such as field trips and independent student projects. In the case of field trips a teacher visitation to the site prior to the trip to determine possible hazards and to forewarn the students is appropriate in addition to general rules for safe conduct before the trip. Individual student projects, whether they are for a classroom project or a science fair, should be given a thorough safety check. During the planning phase of the project students should be thoroughly questioned concerning the safety precautions taken in working on the project and any specific hazards that the project may pose. Any project which will be viewed by the public should be constructed so that observers are protected from possible accidents.

Many teachers find it expedient to use students to run errands both on and off of school property. It is possible that the student would be considered an agent of the teacher and liability for any damage caused by the student or injury to the student would be assessed on the teacher. This practice should, therefore, be avoided.

What are some general safety procedures for the science laboratory?

Conduct a periodic classroom inspection to identify the location and condition of fire extinguishers, first aid kits, showers, and eyewash. General goodhousekeeping should be maintained including the proper storage of materials and equipment.

Be aware of proper accident procedures, fire precautions, and evacuation routes.

Be aware of federal, state, and local regulations which relate to school safety.

Make spill packages available, have metal containers for the disposal of broken glass, and maintain a sand-filled container for the disposal of matches.

Be aware of the location of the main utility shut-off valves and switches for water, gas, and electricity.

Maintain hazardous materials under lock and key at all times. Maintain only minimum amounts of chemicals in the classroom. Lock all laboratory and storage facilities when they are not under direct supervision.

Properly label and date all reagent bottles.

Guard against poisoning by providing adequate ventilation for volatile substances, by providing instruction on the avoidance of ingestion of chemicals or

plants, by identifying dangerous plants and animals, and by providing safeguards against radioactive contamination.

Provide shielding for the teacher and students for demonstrations involving the possible explosion or implosion of apparatus or the possibility of injury due to spattering.

Provide sufficient time for students to set up the equipment, perform the experiment, and properly clean-up and store the materials after use.

Set a good example when performing all demonstrations.

Instruct students concerning specific hazards and precautions at the beginning of each science activity.

Obtain certification in First Aid from the American National Red Cross.

Establish group size appropriate for efficient performance of the exercise without confusion.

Instruct students never to eat or drink in the laboratory and never to use laboratory glassware as a food or drink container.

Demand that chemical goggles be worn in any situation that is a potential source of splashes, spills, or spattering (hazardous chemicals, hot liquids or solids, radioactive materials).

Instruct students never to perform an unauthorized experiment or to use unauthorized equipment or materials.

Caution students to exercise care in noting odors and never to taste, touch, or smell substances without specific instructions from the teacher.

Do not permit students to touch laboratory equipment until instructed to do so.

Perform demonstrations or experiments before allowing students to replicate the activity. Identify hazards related to the procedures, equipment, and materials.

Instruct students never to pipette chemical reagents by mouth.

Instruct students never to force glass tubing into a cork or stopper.

Instruct students to slant test tubes away from themselves when heating them and never to discard matches in the sink. Remind students of the low visibility of burner flames and have them exercise caution regarding long hair and loose clothing.

Have students keep materials other than lab manuals and/or notebooks away from the working area.

Instruct students that it is unsafe to touch the face, mouth, or eyes or other parts of the body after working with plants, animals, or chemicals until they have washed their hands thoroughly.

Provide adequate supervision of the laboratory at all times.

What are some specific safety procedures with regard tro chemicals?

In addition to the safety procedures for each exercise or experiment, the safe use of chemicals involves four major areas. The teacher should be aware of proper storage procedures, proper disposal techniques, chemical toxicity, and unstable or incompatible chemical combinations.

The proper storage of chemicals should provide security against unauthorized removal of the chemical, protect the environment by restricting chemical emissions, and protect the reagents from fire. The room used for this storage should be well ventilated, dry, and protected from sunlight and localized heat such as hot water pipes. The room should always be kept locked when not in use.

Liquid flammables should be stored in safety cans not larger than one gallon in capacity. These should be placed in a separate metal cabinet. This includes such items as gasoline, kerosene, methyl acetate, methyl alcohol, ethyl ketone, petroleum ether, propyl alcohol, pyridine, toluene, turpentine, and xylene.

Oxidizer storage should also be in a separate cabinet which is lightfree and lockable. Chemicals stored here would include ammonium nitrate, potassium chlorate, potassium nitrate, potassium permanganate, sodium nitrate, and metallic sulfates or permanganates.

Control storage (lockable) should be provided for the remainder of the chemicals. Metallic sodium or potassium must be stored under kerosene and containers of sodium, potassium, calcium, or calcium carbide should not be stored above water solutions or containers of water. White phosphorous must be stored and cut under water and the water changed occasionally as it becomes acidic.

Special care should be exercised in the storage and use of ether. Ether reacts slowly with oxygen to form peroxides that are explosive. These unstable peroxides are less volatile than ether and have a tendency to concentrate. For maximum safety ether should be procured in quantities that will be used once opened.

In many school laboratories hoods are used for storing chemical reagents. Storage of volatile or flammable materials in a hood necessitates that the hood operate continuously; most hoods are not designed to function in this manner. Hood storage often results in a corrosive atmosphere which leads to label deterioration. Furthermore, hood storage causes the loss of valuable laboratory space, has no security provisions, and may create hazards due to the presence of incompatible chemicals. Use of a hood for storage should be discouraged.

Often a stockroom refrigerator of the commercial home type is used for storage. This creates a hazard when certain flammable or explosive materials are stored in it. This type of refrigerator has numerous open type switches which can spark and ignite explosive vapors. If a refrigerator is used for this purpose it should be of the laboratory grade explosion-proof variety.

All materials should be stored in containers that are easily handled and resistant in the case of corrosives. A detailed list of chemicals and their proper storage containers is available in *Safety in the Science Laboratory* (Christian, 1968), and *Safety in the Secondary Science Classroom (NSTA, 1978).*

A purchasing philosophy dictated solely by economic considerations can create storage problems. While bulk rates usually result in less unit expense, chemicals should not be purchased in such quantities that they will not be used in a reasonable amount of time. Before any chemical is stored, the label should be checked to ensure that it clearly states what the material is, the type and severity of any associated hazards, precautionary and treatment procedures for the hazard, and the date it was received.

The second area relative to the safe use of chemicals involves proper disposal techniques. The importance of protecting our environment from chemical pollution negates the wholesale use of dilution to dispose of chemicals down the drain. Small amounts of dilute acids, bases, or salt solutions may be flushed down the drain with large amounts of water, but be sure that all materials are water soluble, non-toxic, and in concentrations well below the threshold limit.

Solid materials that can not be flushed because of their insolubility or toxicity should be disposed of in crockery storage jars with protective lids. Flammable solids should not be placed in these containers. Once the waste is collected it can be disposed of in a land fill or other appropriate technique as indicated in the publication *Laboratory Waste Disposal Manual* by the Manufacturing Chemists Association (1973). A partial list of materials that can be disposed of in a land fill or released to the air follows:

Argon
Asphalt
Batteries, dry cell
Boron
Bromochloromethane
Calcium carbonate
Calcium oxide
Carbon black
Carbon tetrafluoride
Chlorobromomethane
Chromium
Crude lime
Dichloromethane
Epoxy resin systems
Ferrosilicon
Helium
Hexachloroethane
Hexafluoroethane
Hydrogen
Lamp bulbs

Latex
Magnesium oxide
Metal scrap
Molybdenum, insoluble compounds
Neon
Nitrogen
Nitrogen fertilizers
Nitrogen trioxidel
Osmium tetroxide
Oxygen
Ozone
Paint
Pyrethrum
Resins
Rubber
Scrap glass
Scrap stoneware
Silica
Sludges
Stone, alberine
Sulfur
Sulfur hexafluoride
Tar
Tetrabromoethane
Tin, organic compounds
Titanium oxide
Tremolite
Trifluoromethane
Urea
Xenon
Yttrium
Zinc oxide

The third area relates to chemical toxicity; *toxic* referring to those materials that cause damage to humans. A representative classification of the level of health hazard is as follows: nuisances, irritants, corrosives, anesthetics, allergens, carcinogens, mutagens, teratogens, toxins, and central nervous system depressants. Very often the safety hazard of a chemical is enumerated and its potential as a health hazard ignored. Carbon disulfide wherein its volatility and flammability are emphasized is an example in that carbon disulfide is also highly toxic, possibly causing damage to the liver, kidneys, and central nervous system. Chemical entry to the human organism occurs through the digestive tract, respiratory tract or skin. The respiratory tract is the most common entry pathway. A partial list of substances whose fumes or dust are toxic when inhaled is as follows:

Acetic acid (concentrated)
Ammonium hydroxide
Benzene
Bromine
Carbon disulphide
Carbon monoxide
Carbon tetrachloride
Chlorine
Formic acid
Hydrochloric acid
Hydrofluoric acid
Hydrogen sulfide gas
Mercury
Nitric acid
Nitrogen oxides
Plastics
Perchloric acid
Potassium hydroxide
Sodium hydroxide
Sulfuric acid (hot or Oleum)
Sulfur dioxide

In many cases skin contact with certain materials should be avoided because of damage to the tissue or because of the ability of the substance to penetrate the skin.

Contact should be avoided in handling substances on the following partial list:

Bromine (liquid)
Carbon tetrachloride
Chromates
Dichromates
Formic acid
Hydrochloric acid
Hydrofluoric acid
Mercury
Nitric acid
Phosphoric acid
(Hot Concentrated)
Potassium hydroxide (solid
and in solution)
Sulfuric acid

Methyl alcohol
Butyl alcohol
Methyl acrylate
Perchloroethylene
Tetraethyl lead
Carbon disulfide
Benzene
Nearly all pesticides

Of additional concern are those substances known to cause cancer in humans. The Occupational Safety and Health Administration has identified the following carcinogens:

Benzidine
Bischlormethyl ether
Beta-Propiolactone
Dichlorobenzidine
Alpha-Naphthylamine
Beta-Naphthylamine
Acetylaminofluorene
Aminodiphenyl
Dimethylaminoazobenzene
Aminodiphenyl
Dimethylaminoazobenzene
Nitrobiphenyl
Nitrosodimethylamine
Methyl Chloromethyl Ether
Methylene (Bis)-Chloroaniline
Ethyleneimine
Vinyl Chloride
Asbestos

Many of these chemicals have more than one name. An article by J. Bradford Block, M.D., contains a list of these carcinogens and their synonyms. This was published in the September 1976 issue of the *Journal of College Science Teaching*. The list is also available from your local chapter of the American Lung Association. As a companion to this list of known carcinogens, the National Institute for Occupational Safety and Health (NIOSH) has published a list of suspected carcinogens. This list is available through the Division of Technical Services, NIOSH, Cincinnati, Ohio, 45226. Any of the substances on these lists should be eliminated from the school laboratory.

The fourth area relative to the safe use of chemicals relates to unstable and/or incompatible chemical combinations. Frequent accidents occur because neither the student nor the instructor is able to anticipate the results of certain chemical combinations. This is not uncommon even among experienced chemists. Instructors should have available a list of unstable chemicals and incompatible combinations. A partial list of unstable chemicals and their properties is as follows:

ether—easily forms explosive peroxides

ammonium nitrate—decomposes exothermically above 160 degrees Celsius, producing a large volume of gaseous products

formic acid—concentrated, it is unstable and has been known to explode

phosphorous-white—spontaneously ignites in air at temperatures above 30 degrees Celsius

ammoniacal silver nitrate solutions (Tollen's reagent) — may produce unstable products which detonate violently when disturbed

benzoyl peroxide—extremely unstable

nitrogen tri-iodide—shock sensitive when dry

picric acid, metal picrates, perchloric acid—very unstable

A partial list of incompatible chemical combinations is as follows:

Incompatible Chemicals

Compound	
Acetic Acid	Nitric acid, peroxides, permanganates, ethylene glycol, hydroxyl compounds
Acetone	Concentrated nitric and sulfuric acid mixtures
Alkali metals; e.g., sodium or potassium	Carbon tetrachloride, carbon dioxide, water, halogenated hydrocarbons
Ammonia, anhydrous	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous)
Ammonium nitrate	Acids, inflammable liquids, metal powders, sulfur, chlorates, any finely divided organic or combustible subtance
Aniline	Nitric acid, hydrogen peroxide
Bromine, chlorine	Ammonia, petroleum gases, hydrogen, sodium, benzene, finely divided metals
Chlorates	Ammonium salts, acids, metal powders, sulfur, any finely divided organic or combustible substance
Chromic acid	Acetic acid, naphtaline, camphors, glycerin, turpentine, alcohol, flammable liquids in general
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, the halogens

THESE CHEMICALS SHOULD NOT COME IN CONTACT WITH:	
Hydrocarbons; e.g. propane, benzene, gasoline, etc.	Fluorine, chlorine, bromine, sodium peroxide
Hydrogen peroxide	Most metals and their salts, alcohols, organic substances, any inflammable substance
Hydrogen sulfide	Oxidizing gases, fuming nitric acid
Iodine	Acetylene, ammonia, hydrogen
Mercury	Acetylene, ammonia
Nitric acid (con.)	Acetic acid, hydrogen sulfide, inflammable liquids and gases
Oxalic acid	Silver, mercury
Potassium chlorate	Sulfuric and other acids, any organic substance
Potassium permanganate	Sulfuric acid, glycerine, ethylene, glycol
Sodium nitrate	Ammonium nitrate and other ammonium salts
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, carbon disulfide, glycerine, ethylene, glycol, ethyl acetate
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate, similar compounds of other light metals

An excellent publication for reference in this area is the *Manual of Hazardous Chemical Reactions* published by the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02110 (1975).

What are some specific safety procedures with regard to microorganisms?

In working with microorganisms the same general safety procedures prevail that would be in force in any science laboratory. The instructor and students, however, should be aware of the additional hazard presented by the possible presence of infectious agents. Although high school students should not work with known pathogenic organisms, all micro-cultures should be treated as though they were pathogenic.

The most common sources of accidental infection occur from oral aspiration through pipettes, accidental syringe inoculation, animal bites, spray from syringes, centrifuge accidents, cuts from contaminated glassware, spilling or dropping pathogenic cultures, laboratory aerosols that may enter the respiratory tract, and contact with infected animals and their cages. Microbiological laboratory procedures that minimize the above dangers should be followed. The transfer and/or inoculation of cultures using a pipette should be accomplished with a bulb. If pipetting by mouth is necessary, a cotton plug should be placed between the liquid and the mouthpiece. The production of aerosols should be minimized by always discharging the pipette below the surface of liquids and by never bubbling air into a liquid nor forcefully ejecting the liquid from the pipette. Used pipettes should be immediately placed in a disinfectant solution and autoclaved before reuse. Accidental syringe inoculation can be avoided by ensuring proper animal restraint during injection. Again, reduce laboratory aerosols by discharging any liquids below the surface of the receiving medium and not by expelling excess liquid into the air. In using an inoculating loop, avoid aerosol production by allowing the loop to cool before insertion into the medium and by avoiding sudden movements that break the loop film. A centrifuge is often used to separate cell suspensions from the medium. All tubes should be inspected to guard against breakage, and the centrifuge cups should be filled with disinfectant as a precaution should breakage occur.

In sampling for microogranisms to inoculate cultures, be aware of the presence of tetanus in soil samples, or typhoid, botulism, and schistosomiasis organisms in standing water and ditches. Exercise care not to contaminate the culture by coughing or sneezing or by prolonged exposure to the air. Care should be taken that excessive distribution of spores and pollen does not occur in the classroom because of possible allergic reactions. Culture dishes that are passed around the classroom or left out for viewing should be taped closed. If a culture is accidentally spilled, the area should be cleaned with a strong disinfectant. All old cultures should be autoclaved before disposal. Liquid disinfectants are useful but should not be relied on for complete sterilization.

What are some specific safety procedures and guidelines when working with plants and animals?

The use of living organisms, both plants and animals, in the classroom can be a motivational tool as well as a vehicle for understanding the concept of life and life processes. The use of living organisms does, however, introduce another spectrum of potential hazards and a new list of teacher and student responsibilities.

All plants have not been thoroughly researched relative to their toxicity. Different parts of the same plant can have different properties. Therefore, in working with plants, never place any part of the plant in the mouth or rub the sap or fruit juice on the skin or into an open wound. Avoid inhalation or exposure of the skin and eyes to smoke from any burning plant or plant parts. Be knowledgeable of the proper recognition procedures for plants. Never pick any strange wild flowers or cultivated plants unknown to you. The following list from the *Oakland County Science Safety Series Reference Guide for Biology* (1977) indicates some plants known to cause reactions:

Apple trees — seeds
Autumn crocus, Star-of-Bethlehem — bulbs
Baneberry — berries
Black locust — bark, sprouts, foliage
Bleeding heart (Dutchman's breeches) — foliage, roots
Crab apple — foliage, seeds
Daphne — berries
Death camas — all parts
Dieffenbachia (Dumb cane), Elephant ear — all parts
Elderberry — all parts except fruits
English holly — berries
Foxglove — leaves
Golden chain — bean-like capsules in which the seeds are suspended
Honeysuckle — seeds
Horsechestnut — leaves, flowers and seeds
Hyacinth, Narcissus, Daffodil — bulbs
Iris — underground stems
Jack-in-the-Pulpit — all parts, especially roots
Jessamine — berries
Jimson weed (thorn apple) — all parts
Lantana camary (red sage) — green berries
Larkspur — young plant, seeds
Laureis, Rhododendron, Azaleas — all parts
Lily-of-the-Valley — leaves, flowers
Maidenhair trees (Ginkgo biloba) — fruit
Marsh marigold (uncooked) — all parts, sap
Mayapple — green apple, foliage, roots
Mistletoe — berries
Monkshood (wolfsbane) — fleshy roots
Moonseed — berries
Mushrooms — all parts
Nightshade — all parts, especially the unripe berry
Oak trees — foliage, acorns unless properly prepared
Oleander — leaves, branches
Peach trees — leaves
Pear trees — leaves
Plum trees — leaves
Poinsettia — leaves
Poison oak, Ivy, Nettles, Common buttercup — all parts
Pokeweed — berries and roots
Potato — vines and foliage, green tubers
Privet, common — berries and leaves
Rosary pea, Castor bean — seeds
Rhubarb — leaf blade
Toadstools and related fungi — all parts
Tomato — vines, foliage
Water hemlock — all parts
White snakeroot — foliage
Wild carrot — foliage
Wild cucumber — seeds
Wild and cultivated cherry trees — twigs, foliage
Wild radish — flowers, fruits, stalks
Wisteria — seeds, pods
Yew — all parts

A more complete reference is *Human Poisoning from Native and Cultivated Plants*, James W. Hardin and Jay M. Aerona, Duke University Press, Durham, North Carolina, 1977.

When working with seeds, be aware that a student may consciously or unconsciously place a seed in his or her mouth. This may create a danger from ingestion of the seed itself or from a coating of hormone, fungicide, and/or insecticide. Seeds should always be inspected for such coatings. When working with pollen or spore producing plants, avoid unnecessary dissemination of pollen grains and spores which can result in bronchial inflammation and/or other allergic responses.

In working with animals in the laboratory, the teacher should be aware of the psychological ramifications of animal experiments, in addition to the safety procedures, and take steps to alleviate any misunderstandings. This necessitates that an adult supervisor assume the primary responsibility for all experiments involving animals. Be aware that some states require special certification before teachers are permitted to experiment with animals. Furthermore, the teacher should take precautions to ensure that all animals used for experimental purposes are lawfully acquired and kept in strict compliance with federal, state, and local laws and regulations. The teacher or qualified assistant should be in charge of the pithing of frogs and the general sedation of all animals.

All animals must receive humane treatment. Animals should be caged so as to avoid animal bites to students and to protect the animals from improper handling by students. Students should be instructed in the proper handling procedures and should wear protective gloves and/or clothing as appropriate. Be aware of the special handling requirements necessary if the animal is pregnant, with young, or hungry. Treat any scratches or bites that are incurred promptly and isolate the animal for ten days. The animal care facilities should be cleaned frequently enough to remove animal wastes, control vermin, and keep the concentration of pathogenic microorganisms at a minimum. Optimum housing conditions for each species should be maintained, including proper diet and sufficient water. Cold blooded animals should be returned to a care facility that approximates their natural environment as soon as possible after handling, and turtles should be handled as little as possible because they may carry salmonella. Poisonous snakes, snapping turtles, disease-carrying insects, and harmful spiders should not be kept in the classroom. In animal experiments the animals should not be subjected to stress, pain, or discomfort. Deficiency experiments should be conducted only to the symptomatic stage and should cease before debilitating the animal. No surgery should be performed on any living vertebrate. Eggs that have been manipulated during development should not be allowed to hatch. Obtain all animals from a reputable supply house; avoid bringing wild animals into the classroom. Any disposal of animals should be accomplished in a humane fashion out of sight of the students.

The National Science Teachers Association has established a code of practice on using animals in the classroom. The details of this code can be found in the September, 1980 issue of *The Science Teacher*.

Disease control is another area of responsibility in caring for animals. Diseases can be transmitted among animals, from animals to humans, and from humans to animals. Animals can contract salmonellosis, influenza, tuberculosis, and infectious hepatitis from humans. Humans can contract many diseases from animals. Instructors and students should be alert to danger signs that may indicate disease. These danger signs include an unusual odor emanating from the cage, a sluggish or unresponsive animal, constant or unusual bickering among inmates, loss of appetite, an unhealthy pallor or color change in hair, eyes, or skin, unusual discharge from body openings, or frequent sneezing. An animal suspected of disease should be isolated, its quarters disinfected, and if the diseased condition persists, humanely destroyed.

What are some specific safety procedures when using electricity?

The basic hazard when using electricity is that of being subjected to electrical shock. Electrocution can occur under a variety of circumstances. It is actually the amount of current that flows through the body that determines the severity of the shock. Severe shock hazards can therefore exist even when using relatively low voltages. The amount of current flowing through the body is determined by the interaction of the factors expressed in Ohm's law

$$\text{current} = \frac{\text{voltage}}{\text{resistance}}.$$

Therefore, with a constant voltage, the current that flows through the body increases as the resistance decreases. The body has a fairly low resistance but the skin has a high resistance, about 500,000 Ohms. Conditions that allow more than 10 milliamps to flow through the body will cause a painful shock. Conditions that result in a flow of from 100 to 200 milliamps may cause severe burns and unconsciousness. This is usually not fatal if treated promptly. Conditions that result in a current flow above 200 milliamps are usually fatal. The severity of the shock is also related to the nature and area of the contact surface, the time of contact, and the pathway that the current takes through the body.

Electrical safety procedures involve controlling the above factors so that electric current does not flow through the body. Even a normal 110 volt power line can be very dangerous. Electrical circuits and equipment should only be handled with dry hands. Moisture on the skin reduces its resistance from about 500,000 ohms to 1,000 ohms, creating a shock hazard. Electrical equipment should only be handled on a nonmetallic floor. Rubber mats are preferrable and the floor must be dry. The teacher or students should be sure that the person is not grounded nor in contact with any grounded items. The following is a partial list of additional procedures:

1. Test all electrical equipment for leakage and refrain from using equipment that produces even a slight shock. Check electrical equipment for approval by the Underwriter's Laboratories or some other recognized testing lab.
2. Shield all live electrical switches and connections, clearly label all switches and circuit breakers for the open and closed positions, and be aware of the location of the main breaker for the laboratory circuits.
3. Do not touch circuit parts with the power on. Use tools with insulated handles, and check all circuits used by students before current is allowed to flow.
4. When assembling circuits connect the live portion last; when disassembling disconnect the live portion first.
5. When plugging in equipment beware of sparks from a possible short circuit. When removing plugs pull by the plug, not the cord.
6. Do not connect appliance, equipment, or extension cords to light sockets. Make sure that all electrical appliances and equipment are properly grounded.

The major information sources for the above were the *Oakland County Reference Guide for Physics and Physical Science* (1977) and *Safety in the Secondary Science Classroom* (NSTA, 1978). An additional source is the *Modern Chemical Technology Guidebook for Chemical Technicians*, American Chemical Society, Washington, DC (1970).

What are some specific safety procedures when using lasers?

The main hazard when working with lasers involves possible injury to the eye. Even low laser power can cause retinal burns. If the area involves the macula, fovea, or optic nerve, severe permanent damage may result. Additional laser hazards involve the potential for first and second degree burns as a result of exposure to beams from high-powered solid state or junction lasers. Electric shocks and burns may result from inadvertant contact with the input power or from a capacitor discharge. X-rays may be given off by some equipment. Burns can

result from contact with liquid gas coolants.

Potential hazards of laser beams to the eyes are dependent on the laser power, beam diameter, distance from the beam, the color of the light, the angle of the beam, the focal length of the eye, and the diameter of the eye opening. Therefore, the optical power should be reduced to the lowest level necessary to accomplish the instructional objective, with a .5 milliwatt Helium-Neon laser being the maximum required for high school demonstrations. The general illumination of the room should be kept high so that the pupils of the eyes are not dilated. All optical components should be rigidly fixed. All reflective objects should be removed from the anticipated laser path. All personnel should remain away from the sides of that path. A cover should be used to block the beam when it is not in use. Security should be provided by equipping the primary circuit with a key switch. If at any time the interaction of the above stated factors exceeds threshold limits, glasses certified as protection for lasers should be worn. The *Oakland Reference Guide for Physics and Physical Science* (1977) indicates that exposure of the retina to radiation of one millijoule per cm^2 for one millisecond from a ruby laser has caused retinal burns. For additional procedures see the *Handbook of Laboratory Safety*, Second Edition, The Chemical Rubber Company, Cleveland, Ohio (1971).

What are some specific safety procedures when using model rockets?

The Federal Aviation Agency has established regulations concerning the launching of model rockets launching of model rockets (see *Moored Balloons, Kites, Unmanned Rockets, and Unmanned Free Balloons* (Department of Transportation)). Some states have enacted laws regulating model rocket launching. Laws and regulations address such items as rocket design, construction and weight, and propellant type and amount. In all cases rockets must be operated so as not to create a hazard to persons, property or other aircraft. The following guidelines were adopted from the *Oakland County Reference Guide for Physics and Physical Science* (1977):

1. The total rocket weight, including the engine, should not exceed 16 ounces.
2. There should be not more than 4 ounces of fuel in the rocket engine at the time of launch.
3. The rocket should be designed for re-use with a system to slow the rocket's return and thus minimize damage.
4. The rocket should be constructed for maximum in-flight stability with a minimum of metal parts.
5. The rocket should not contain an explosive or pyrotechnic warhead.
6. The engine should be commercially prepared with all fuels already mixed. The engine should be incapable of igniting or exploding at temperatures of less than 170 degrees F. Spontaneous combustion should not occur in air, under water or glycerine or when subjected to shock or pressure.
7. The launch area should include 5,000 square yards and, when approximating a rectangle, have no side less than 50 yards. The flight area should be free of high voltage lines, major highways, water towers, multi-story buildings, and other obstacles.
8. Launch ignition should be accomplished electrically by remote control. Persons in the launch area should be warned when the launch is imminent.
9. Rockets should not be launched in cloud cover or at night. At launch time the wind speed should not exceed 20 miles per hour and visibility should be less than 2,000 feet.
10. A launch area can not be used if it is within four miles of the boundary of any airport.
11. The launch angle should be between 60° and 90° from the horizontal. An adult should inspect the rocket and launch area prior to flight and supervise the launch.
12. The rocket can not be used for a fireworks display.
13. Unmanned rockets cannot be launched unless proper notice has been given to the Federal Aviation Agency Air Traffic Control facility as indicated by F.A.A. regulation Volume VI, Sec. 101.25.

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Recent ERIC/SMEAC Publications

Readers wishing to order a copy of any of these publications may either purchase them from the ERIC Clearinghouse for Science, Mathematics and Environmental Education or may order from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or papercopy. Prices and ordering information are found in the document resumes in *Resources in Education* (RIE) as are order forms.

Science Education

Review of Research: Teacher Questioning Behavior in Science Classrooms
Patricia E. Blosser ED 184 818

Dissertations and other research reports related to science teacher questioning behavior are analyzed. Research is summarized separately for observational studies and experimental studies.

1980 AETS Yearbook: The Psychology of Teaching for Thinking and Creativity
Anton E. Lawson, editor ED 184 894

The focus of this yearbook is on the relationship of teaching thinking and creativity in a science education context. Following a foreword by Piaget are 11 chapters by Rogert Gagne, Constance Kamii, Robbie Case, A. E. Lawson and C. A. Lawson, Robert Karplus, D. P. Ausubel, J. D. Novak, E. P. Torrence, J. A. Vargas and P. A. Moxley, and M. A. Mogus.

ERIC

ERIC CLEARINGHOUSE FOR SCIENCE, MATHEMATICS, AND ENVIRONMENTAL EDUCATION
1200 Chambers Road
Columbus, Ohio 43212

A JOINT PROJECT OF THE NATIONAL INSTITUTE OF EDUCATION and THE OHIO STATE UNIVERSITY

This newsletter was prepared pursuant to a contract with the National Institute of Education, U.S. Department of Education. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions, however, do not necessarily represent the official views or opinions of the National Institute of Education.

Patricia E. Blosser
Bulletin Editor

Outdoor Areas as Learning Libraries, CESI Sourcebook, An Occasional Sourcebook of the Council for Elementary Science, International
Alan J. McCormack, editor ED 183 374

Ideas for outdoor learning activities appropriate for youngsters in elementary, middle and junior high schools are presented. These activities are designed to assist the teacher in using outdoor areas surrounding the school as a laboratory for effective instruction.

National Association for Research in Science Teaching 53rd Annual Meeting, Abstracts of Printed Papers.
Arthur L. White, editor ED 182 116

Abstracts of papers presented at the 1980 meeting relate to research techniques, learning, cognitive development, instruction, science curriculum, teacher education (preservice, inservice), and other topics.

SOME FREE, USEFUL MATERIALS ABOUT ERIC®

From time to time, people who visit the ERIC display at some educational meeting express surprise when they see materials about ERIC which are free for the asking. As a service to readers, we have included a form to be completed and returned in order to receive some, or all, of these materials.

Available materials include a listing of ERIC microfiche locations by state, a list of computer search services available by state, "A Short Guide to ERIC and ERIC/SMEAC," and the publications list from the ERIC Clearinghouse for Science, Mathematics and Environmental Education.

Information about ERIC microfiche locations includes the address of the collection and hours it is available for use, telephone number to call and name of individual in charge of the collection, status of the collection (years of microfiche included) and equipment available for use, as well as reproduction services available.

For computer search services, the address, telephone number and name of the person to contact are also given. Additional information includes the approximate cost of a search, length of time needed to produce the search as well as files to be searched and the format in which the search question must be structured.

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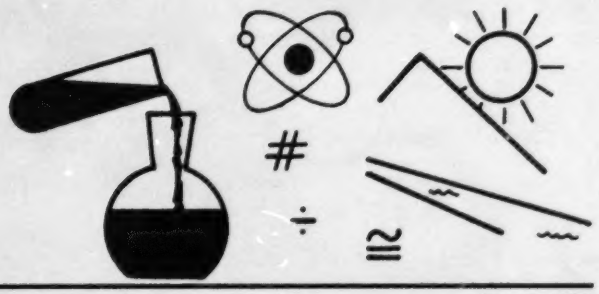

Information Bulletin No. 4 1980

Editor's Comments

The three previous 1980 issues of the ERIC/SMEAC information bulletin have been focused on a single theme for each issue reflecting a concern of one of the areas within the scope of the Clearinghouse: science education, mathematics education, or environmental education. This fourth, annual, issue may be said to have a theme, also, in that much of the material relates to activities of the ERIC system in general and to those of ERIC/SMEAC in particular.

It is of particular importance that readers of this bulletin read carefully (rather than scan) the information dealing with changes in distribution procedures of information bulletins and fact sheets. In the past the editor has received letters and telephone calls from persons concerned by the fact that they had not received an issue within the time span they had anticipated for another mailing and wanted to make certain they were still on the ERIC/SMEAC mailing list. The standard response was an apology and a brief explanation that other duties took priority over production of another issue of the information bulletin but that one would be in print in the near future and they would receive a copy. From this point on, that explanation is no longer a valid one. If readers fail to complete the form on the last page of the bulletin and do not mail it to ERIC/SMEAC, their earlier assumption will be true: their names and addresses will no longer be on the ERIC/SMEAC mailing list. Also, please take notice of the fact that there is a subscription cost involved if present recipients of the ERIC/SMEAC information bulletin are to receive all four issues produced each year.

Changes in ERIC/SMEAC Information and Fact Sheet Series Mailings

IMPORTANT! PLEASE NOTE!

For the past several years, we have been providing free copies of our information bulletins and fact sheets as long as funds were available to print them. For the past two years, we have mailed or distributed at meetings about 20,000 of each issue free. Requests for bulletins, however, have exceeded 60,000 for every issue published. Requests for several issues have exceeded 80,000.

Due to lack of funds we can not continue to send information bulletins and fact sheets to all people requesting these items at no charge to them. We do, however, plan to continue to offer the annual bulletin issue (fourth issue each year) at no charge to all people on our mailing list.

We will maintain a small mailing list of people and agencies who will receive single copies of the information bulletins and fact sheets at no charge. Included in these groups are ERIC Standing Order Customers, State Coordinators and Dissemination Officers, Federal Agencies, some school districts, some teacher education institutions, and the headquarters office of professional associations and journals.

If there is an X on your mailing label, your name and address will be retained on the list of persons and organizations receiving free bulletins. If there is *no* X on your mailing label, you will continue to receive the annual bulletin issue at no charge but you must subscribe to receive the other issues of the information bulletins and the fact sheets. An explanation of subscription costs is given on page 4. A subscription order form is found on the next to the last page of this bulletin.

Please check your mailing label for accuracy of the information. A form for requesting changes is found on the last page of this bulletin. Please return this form so that we can maintain accurate addresses for publication announcements, annual bulletins, and other mailings.

Recent ERIC/SMEAC Information Analysis Products

Each of the Associate Directors of the ERIC Clearinghouse for Science, Mathematics and Environmental Education (Drs. Helgeson, Suydam, and Disinger) was asked to identify several documents produced by the Clearinghouse in 1979-1980 to be highlighted for the readers of this bulletin. This highlighting has taken the form of an expanded descriptive abstract of the document.

Science Education

Outdoor Areas as Learning Laboratories, CESI Sourcebook
Alan J. McCormack, compiler and editor

This sourcebook which describes practical and exciting activities to supplement and enrich science programs is focused on using outdoor sites as laboratories. School site laboratories were chosen because right there, where teachers are, are opportunities to study the environment while practicing investigatory skills. The contributors believe that learning is enhanced when children can directly touch, see, and explore for themselves. The key is to find some interesting problems that children can investigate in their local environment.

The book is intended to be a source of ideas for outdoor learning activities appropriate for youngsters in elementary, middle and junior high schools. It may also be useful for anyone who works with children in outdoor settings: camp counselors, boy/girl scout leaders, park recreation specialists, nature interpreters.

These "kid-tested" activities have been grouped into animal studies, plant studies, ecology activities, physical science activities, and interdisciplinary activities. An appendix contains plans for building instruments (hypsometer, CESI bug catcher, wind vane, anemometer, human hair hygrometer, aquatic sampling tools) to use in outdoor studies. ERIC/SMEAC price: $6.50 (ED 183 374)

The Psychology of Teaching for Thinking and Creativity
Anton E. Lawson, editor

Part of the AETS yearbook series, this volume provides a single forum for the presentation of the prominent psychological views on the development of the

intellect and how instruction can assist in this most significant development.

Authors who contributed chapters to this yearbook were asked to read *The Central Purpose of American Education,* produced in 1961 by the Educational Policies Commission of the National Education Association. In this small volume, the essence of the ability to think is characterized as involving the rational processes of recalling and imagining, classifying and generalizing, comparing and evaluating, analyzing and synthesizing, and deducing and inferring. Each author was asked to respond to six questions at some point in his/her chapter so that areas of agreement and disagreement among authors could be identified.

Piagetian, Neo-Piagetian, Gagneian, Ausubelian, and Skinnerian points of view are presented, as is a chapter reflecting the point of view of Humanistic psychologists. In addition there are chapters dealing witrh creativity, with current areas of psychological research, and with split-brain research.
ERIC/SMEAC price: $7.00(ED 184 894)

Science for the Handicapped, An Annotated Bibliography
Ben Thompson, editor

This annotated bibliography represents, for the first time, a single source of information on science education for the handicapped. Entries are grouped under the following headings: The Visually Impaired-General, The Visually Impaired-Research, The Hearing Impaired-General, The Hearing Impaired-Research, Other Handicapping Conditions-General, and Other Handicapping Conditions-Research.

Materials identified include journal articles, books, and papers presented at regional and national meetings. Some foreign language entries are included. ERIC/SMEAC price: $3.50 (SE 033 907)

Mathematics Education

Interactions of Science and Mathematics
Peggy A. House

This publication includes 47 investigations" . . . for every science teacher whose students have moaned about the mathematics involved, and for every mathematics teacher whose students have asked 'Why do we need to know this?' "

The author emphasizes:

a. *patterns* which we observe in selected physical situations;
b. *variables* and other mathematical symbols which we use to represent patterns;
c. *functions* which describe the relationships among quantities or objects — these include both *numerical* and *spatial* relationships;
d. *measurement* and the gathering, organizing, communicating, and using of data; and
e. *models* or abstractions which enable us to explain, to predict, and to make decisions.

Many of the investigations are commonly included in junior and senior high school science laboratory activities. The required equipment is easy to assemble or typically available from school science departments. Each investigation also deals with one or more important mathematical concepts found in junior and senior high school curricula. The activities can be conducted during typical class periods and adapted to meet the needs of a teacher's own students. ERIC/SMEAC price: $6.00 (SE 033 191)

International Calculator Review
Marilyn N. Suydam

The current status of calculator use in sixteen countries is reviewed in this publication.

Comments on the following issues are included in the individual national reports:

- At what levels should calculators be used?
- How should calculators be used — as computational tools and/or as instructional aids?
- Should calculators be used on tests?

In addition, the reports discuss:

- Trends, predictions, and prevailing opinions about curricular implications of calculators
- Research activities with calculators
- Instructional practices
- Student outcomes, attitudes, and concerns
- In-service activities for teachers
- General background on amount of use, type of use, projects, etc.

This review also includes a list of selected references, a report of the International Working Group on Calculators, and comments synthesizing the individual national reports. ERIC/SMEAC price: $3.00 (ED 190 408)

Environmental Education

A Directory of Projects and Programs in Environmental Education for Elementary and Secondary Schools, Fifth Edition
John F. Disinger, compiler-editor

Exemplary projects and programs related to K-12 education are presented in this book, based on recommendations from environmental education specialists from 49 state education agencies. Directors of the projects and programs were invited to submit reports, based on a questionnaire, concerning their efforts. This volume contains the 284 responses that were received. Foci of various efforts include conservation education, outdoor education, natural resources management, energy education, population education, marine and aquatic education, and urban environmental education. Information included relates to goals, objectives, program, staffing, funding, history, materials produced, and plans for the future. ERIC/SMEAC price: $16.00 (ED 187 515)

Strategies and Activities for Using Local Communities as Environmental Education Sites
Charles E. Roth and Linda G. Lockwood

More than 100 activities in which the local community is used as a learning site and resource are presented in this book. Activities are appropriate to both classroom and less formal educational settings. Among the learning strategies employed are field trips, community inventories, simulations, values clarification activities, and community action projects. Intended for nine through eighteen year old students, these activities have been compiled from currently available materials. Appendices include listings of reference materials and sources of community information. ERIC/SMEAC price: $5.50 (SE 033 190)

Teaching Basic Skills through Environmental Education Activities
Mary Lynne Bowman

Classroom activities for students in grades K-12 provide a variety of approaches to using environmental education content and examples in the teaching of basic skills. Particular attention is paid to language arts and mathematics. The philosophy espoused is that environmental education is not a discrete area of study but, instead, involves a number of disciplines and provides appropriate foci and examples for all curricular areas. ERIC/SMEAC price: $4.00 (SE 033 691)

Current Issues VI.: The Yearbook of Environmental Education and Environmental Studies. Selected Papers from the Ninth Annual Conference of the National Association for Environmental Education (Albuquerque, 1980)
Arthur B. Sacks, Lei Lane Burrus-Bammel, Craig B. Davis, Louis A. Iozzi, editors

Following a foreword by Lynton K. Caldwell, papers are presented that were selected from those given at the 1980 conference. The papers are arranged in two sections. The first section contains 10 descriptive papers while the second section contains 22 papers based on original research and thought. Among the areas addressed are energy and transportation, environmental educa-

tion and citizen action, land use, environmental health, attitudes, values, judgments, and awareness, and assessing environmental education teachers and curricula. This is the sixth annual volume of NAEE conference papers published by ERIC/SMEAC. ERIC/SMEAC price: $7.50 (SE 033 908)

Readers wishing to order a copy of any of these publications may either contact the ERIC Clearinghouse for Science, Mathematics and Environmental Education and order directly from the Clearinghouse or purchase the publications from the ERIC Document Reproduction Service (EDRS), P.O. Box 190, Arlington, VA 22210. Materials ordered from EDRS may be purchased as microfiche or as papercopy. Prices for microfiche or papercopy are quoted in the document resumes in *Resources in Education* (RIE). Clearinghouse documents with SE numbers have been sent to EDRS for inclusion in some future issue of RIE. When the document resume appears in RIE, it will have an ED number in addition to its SE number.

ERIC/SMEAC prices for these documents are for pre-paid orders. There is an additional postage-and-handling charge for orders which must be billed to some individual or organization.

ERIC Clearinghouse Network

As most readers of this bulletin know, ERIC is an acronym for the Educational Resources Information Center, which is not really a center but is, rather, a nationwide network of 16 clearinghouses under the direction of the National Institute of Education (NIE). Each clearinghouse specializes in a particular area of education and works with Central ERIC in NIE to form a national information system. The clearinghouses and their addresses and phone numbers are listed below.

ADULT, CAREER, AND VOCATIONAL EDUCATION
The Ohio State University
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1960 Kenny Road
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University of Michigan
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Ann Arbor, Michigan 48109
(313) 764-9492

ELEMENTARY AND EARLY CHILDHOOD EDUCATION
University of Illinois
College of Education
131 South Sixth St.
Champaign, Illinois 61820
(217) 333-1386

EDUCATIONAL MANAGEMENT
University of Oregon
Eugene, Oregon 97403
(503) 686-5043

HANDICAPPED AND GIFTED CHILDREN
Council for Exceptional Children
1920 Association Drive
Reston, Virginia 22091
(703) 620-3660

HIGHER EDUCATION
George Washington University
One Dupont Circle, Suite 630
Washington, DC 20036
(202) 296-2597

INFORMATION RESOURCES
Syracuse University
School of Education
Syracuse, New York 13210
(315) 423-3640

JUNIOR COLLEGES
University of California at Los Angeles
Powell Library, Room 96
Los Angeles, California 90024
(213) 825-3931

LANGUAGES AND LINGUISTICS
Center for Applied Linguistics
3520 Prospect St., N.W.
Washington, D.C. 20007
(202) 298-9292

READING AND COMMUNICATION SKILLS
National Council of Teachers of English
1111 Kenyon Road
Urbana, Illinois 61801
(217) 328-3870

RURAL EDUCATION AND SMALL SCHOOLS
New Mexico State University
Box 3AP
Las Cruces, New Mexico 88003
(505) 646-2623

SCIENCE, MATHEMATICS, AND ENVIRONMENTAL EDUCATION
The Ohio State University
1200 Chambers Road, Third Floor
Columbus, Ohio 43212
(614) 422-6717

SOCIAL STUDIES/SOCIAL SCIENCE EDUCATION
855 Broadway
Boulder, Colorado 80302
(303) 492-8434

TEACHER EDUCATION
American Association of Colleges for Teacher Education
One Dupont Circle, NW, Suite 616
Washington, DC 20036
(202) 293-7280

TESTS, MEASUREMENT, AND EVALUATION
Educational Testing Services
Princeton, New Jersey 08541
(609) 921-9000 ext. 2176

URBAN EDUCATION
Box 40
Teachers College, Columbia University
525 W. 120th Street
New York, New York 10027
(212) 678-3437

Readers may wish to write to one or more clearinghouses to request a copy of that particular clearinghouse's publications list or to be placed on the mailing list.

If readers are interested in submitting educational materials to the ERIC data base, they may send these materials to a specific clearinghouse if the materials fall within the clearinghouse's scope of interest. It is also possible to send materials to the ERIC Processing and Reference Facility for distribution to the appropriate clearinghouse. The Facility's address is

ERIC Processing and Reference Facility
4833 Rugby Avenue, Suite 303
Bethesda, MD 20014.

Completely Revised ERIC *THESAURUS* Now Available

The latest issue of the *Thesaurus of ERIC Descriptors* is the result of a two-and one-half year project designed to eliminate flaws that had developed in the *Thesaurus* during the 12 years it has been in use in the ERIC system. Scope notes (operational definitions) were missing for some critical terms, several descriptors were nearly synonymous, some terms were used improperly, a few hierarchies were incomplete or otherwise unsound, and for at least one term there were no citations.

Personnel from the different ERIC clearinghouses were involved in a Vocabulary Improvement Project which brought about the changes in the completely revised *Thesaurus*. All of the descriptors were examined. A total of 1,017 terms were purged or deleted, new descriptors (498) were added, and 1,437 scope notes were added to provide operational definitions for terms. Also, 123 descriptors were categorized as invalid. These terms have a notation indicating the span of time during which the term was used as well as a scope note designed to indicate a more precise term to use.

The new *Thesaurus* should be easier to use because it is much more informative than were earlier editions. One major improvement is the change to word-by-word alphabetization rather than the letter-by-letter method previously used. In the revised *Thesaurus* "Laboratory" terms don't come between "Labor" and "Labor Conditions." Another example of simplification is the change from somewhat obscure and stilted words and phrases ("Administrative Personnel" for example) to more straight-forward terms ("Administrators"). Many ambiguous and misleading terms have been given scope notes. "Teacher Attitudes" now carries the scope note "Attitudes of, not toward, teachers."

Because 1,017 descriptors were eliminated, there is an increased incidence of "Use" references. For example "Laboratory Techniques" was an acceptable descriptor for the period 1967-1980; now the term used is "Laboratory Procedures." This means that searchers wishing to make a complete literature review need to use "Laboratory Techniques" to retrieve citations placed in the ERIC data base from 1967 through 1980 but, for citations from 1980 on, they will need to search under "Laboratory Procedures."

The introduction section of the revised *Thesaurus* provides the user with an excellent overview of the changes that have taken place. Indexing from the new *Thesaurus* began with the August, 1980,

issues of *Resources in Education* and *Current Index to Journals in Education*. The *Thesaurus* is published by Oryx Press, 2214 North Central at Encanto, Phoenix, AZ, for $13.20 domestic and $14.40 foreign rates.

Reference Volumes for ERIC Data Base Available

Reference tools that enable ERIC users to find material in *Resources in Education* (RIE) are available. These tools are the 1980 Semiannual Index, the 1979 Annual Cumulations, and the 1980 Annual Cumulations.

The *1980 Semiannual Index* to RIE covers the January-June 1980 issues. This volume contains indexes by subject, author, institution, and publication type as well as clearinghouse ED number cross-references and new thesaurus terms. The cost of the volume is $8 domestic, $10 foreign. Send orders to **Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.**

Only the January-June index was published in 1980; the July-December issue will not be published. An index to RIE citations for July-December 1980 will be available only in the annual cumulation volumes which are published by Oryx Press.

The *1979 Annual Cumulations* make available all twelve issues of *Resources in Education* published in a three-volume hardbound set. The *Annual Cumulation: Abstracts* (two volumes) provides descriptions and abstracts of each document announced in RIE in 1979. It is priced at $80 domestic, $85 foreign. The *Annual Cumulation: Index* (one volume) contains subject, author, and institution indexes. Its price is $47.50 domestic, $50 foreign. All three volumes are $127.50 domestic, $135 foreign. Prices include postage and handling.

The 1980 versions of these *Cumulations* are also available. The *Annual Cumulation: Abstracts*, which provides descriptions and abstracts of each document announced in RIE in 1980, is priced at $90 for the two-volume set for domestic customers, $95 foreign. The *Annual Cumulation: Index* for 1980 is priced at $47.50 domestic, $50 foreign. All three volumes are available for $137.50 for domestic customers and $145 for foreign customers. Prices include postage and handling.

Orders for these cumulations should be sent to:

Oryx Press
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Our Clearinghouse plans to produce *four* information bulletins in 1981. Each bulletin will be eight pages in length. A subscription for the four bulletins for 1981 is $3.00.

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3. Scanned Computer Searches of the ERIC Data Base (RIE and/or CIJE)

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4. Evaluative Comments Related to the Output of the Computer Search

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Our Clearinghouse has cooperated with The Ohio State University to produce compilations that provide abstracts, a descriptor index, an identifier index, an author index, and an institutional index for each of our areas of responsibility: science education, mathematics education, and environmental education. These publications are "bargains" compared to *any* computer searches and permit manual searches at a very rapid rate. Compilations for 1978-1980 are being produced. These publications are listed in the ERIC/SMEAC publications list and are priced from $15 to $22 each, depending upon the document.

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Patricia E. Blosser
Bulletin Editor

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